9-2020

ME-EM 2019-20 Annual Report

Department of Mechanical Engineering-Engineering Mechanics, Michigan Technological University

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ME-EM

MECHANICAL ENGINEERING — ENGINEERING MECHANICS

ELEMENTS OF EXCELLENCE

PAGES 2-51 →

Michigan Technological University

1885

[2019-20] ANNUAL REPORT

DEAR ALUMNI & FRIENDS

Over the course of my 45 years in the Department, our faculty, staff, and students have unlocked many Elements of Excellence. From our faculty's commitment to student success in the redevelopment of the curriculum to the extracurricular activities and research projects, I am proud to tell these stories.

This year, I focus on the elements of excellence that make the Department unique. Countless hours are spent by our faculty and staff to ensure our students are receiving the best possible education—both through the curriculum and in preparing for virtual learning.

I hope that by sharing these experiences, others can learn about the phases our Department has gone through in our quest for excellence.

Throughout Element 1, we discuss curriculum innovations past, present, and future; these ensure our students are prepared to contribute as mechanical engineers from day one of their careers.

Element 2 focuses on our development of leaders by highlighting lunar competitions sponsored by NASA, fostering autonomy in the SAE AutoDrive Challenge, launching satellites into space through the Aerospace Enterprise, and developing remotely accessible research buoys in our wave tank. We continue to provide a high level of support to our students through industry sponsorships and dedicated faculty committed to our vision of excellence.

Note: Pre-COVID images were utilized throughout this report and are dated.

Building on our prior success, our faculty have expanded intra- and interuniversity collaboration in the research centers and institutes we feature throughout Element 3, including US-COMP and two newly proposed centers.

This year we highlight Element 4—rapid adaptability—through our swift transition to an online learning model for faculty and students and adapting our research to combat the COVID-19 pandemic.

Our Department's success has only been made possible through the widespread engagement of our community—from the students to our dedicated faculty and staff, with further support from the University, as well as the generous contributions of alumni, friends, and corporate sponsors.

I am grateful for the trust you have offered me and the contribution each of you has made toward our endeavor to achieve sustained excellence.

William W. Predebon

William W. Predebon, PhD
J.S. Endowed Department Chair & ME-EM Professor
wwpredeb@mtu.edu

CENTERED ON RESEARCH

We have made significant progress toward securing national research centers and institutes in our thrust areas. We have further sustained efforts to attract high quality and diverse faculty and staff supporting broad research capabilities.

Our faculty have persisted in obtaining high value contracts and grants. Dr. Sajjad Bigham has advanced the additive manufacturing process, creating heat exchangers suitable for extreme temperature and pressure through a $2.4 million grant from the Department of Energy's (DOE) Advanced Research Project-Energy (ARPA-E) (pg. 34).

Dr. Paul van Susante is eliminating the need for liquid oxygen and hydrogen propellant by sourcing water as fuel and oxidizer from the environment on the moon or Mars (pg. 30).

APS Labs is completing the ARPA-E contract, outfitting a fleet of eight Gen II Chevy Volts to achieve 20 percent reduction in energy consumption in light-duty hybrid electric vehicles. Researchers involved, such as Drs. Jeff Naber and Darrell Robinette, are testing vehicles using the Advanced Drivetrain and Propulsion Technologies (ADAPT) Test Cell (pg. 32).

US-COMP, a Michigan Tech-based institute, is on its way to a lighter and stronger carbon nanotube-based composite for the next generation of space exploration for NASA (pg. 38).

Under the direction of Dr. Ezra Bar-Ziv, the WASTE Center has applied for funding from the DOE for an opportunity to turn unutilized plastic waste into composite materials for useable feedstock for manufacturing (pg. 36).

The Engineering Research Center for Emerging Disaster Engineering Encompassing Human Directed Expert Systems (ERC-DEES), under the direction of Naber, is developing tools for communities, first responders, and agencies for real-time decision making in emerging disasters (pg. 40).

Through growth of our research, we have been able to attract and retain highly qualified graduate students and faculty who are recognized experts in their fields.

NATIONAL SCIENCE FOUNDATION

16

16 in research expenditures among all mechanical research in the US

US NEWS & WORLD REPORT: AMERICA'S BEST

34

Undergraduate Schools: 34 (top 10%) among all US doctoral-granting universities

US NEWS & WORLD REPORT: AMERICA'S BEST

65

Graduate Schools: 65 (top 38%) among all US doctoral-granting ME departments

AMERICAN SOCIETY FOR ENGINEERING EDUCATION

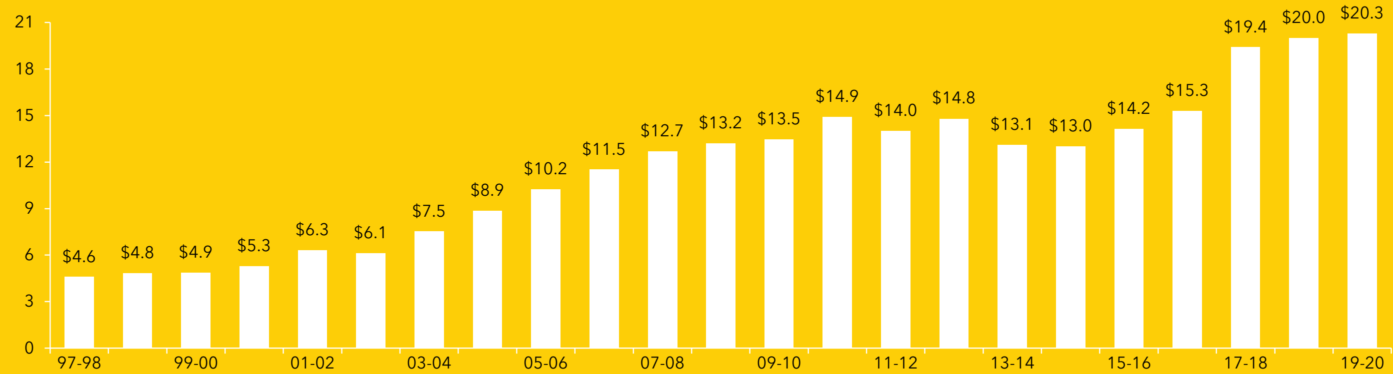
BSME: 8 in enrollment, 19 in degrees awarded

MSME: 5 in enrollment, 16 in degrees awarded

PhD: 26 in enrollment, 21 in degrees awarded

1997-2020 RESEARCH EXPENDITURES

Reported by the National Science Foundation (NSF)—in millions



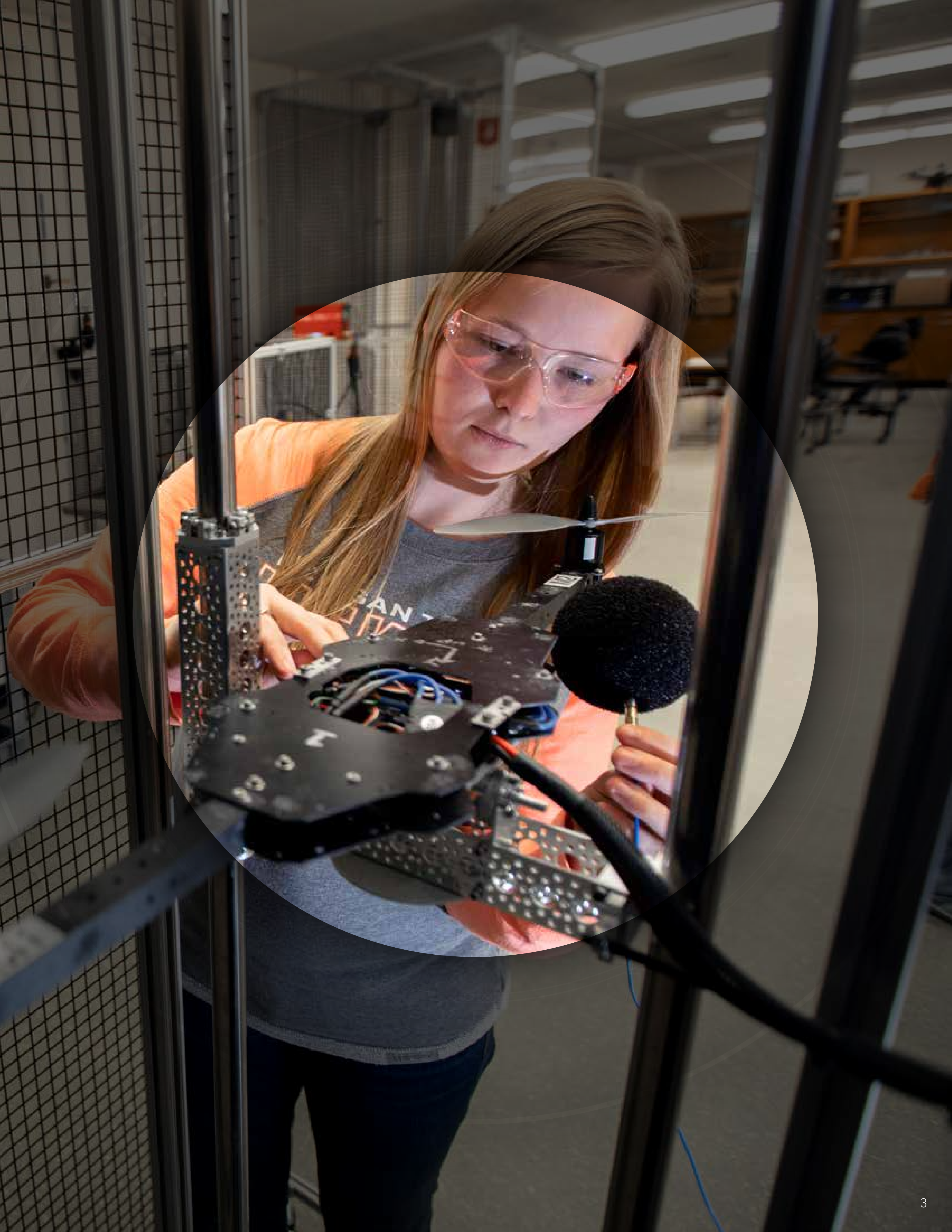
Research expenditures are an estimate at publication time and are corrected in the next annual report.

ELEMENT 1

REINVENTING THE WHEEL

Best practices in mechanical engineering change constantly. Faculty in the ME-EM Department recognize the value of hands-on labs and adjusted course content to deliver the maximum value for our students.

These shifts have taken place several times over the past 20 years, ensuring our students are prepared now and in the future.

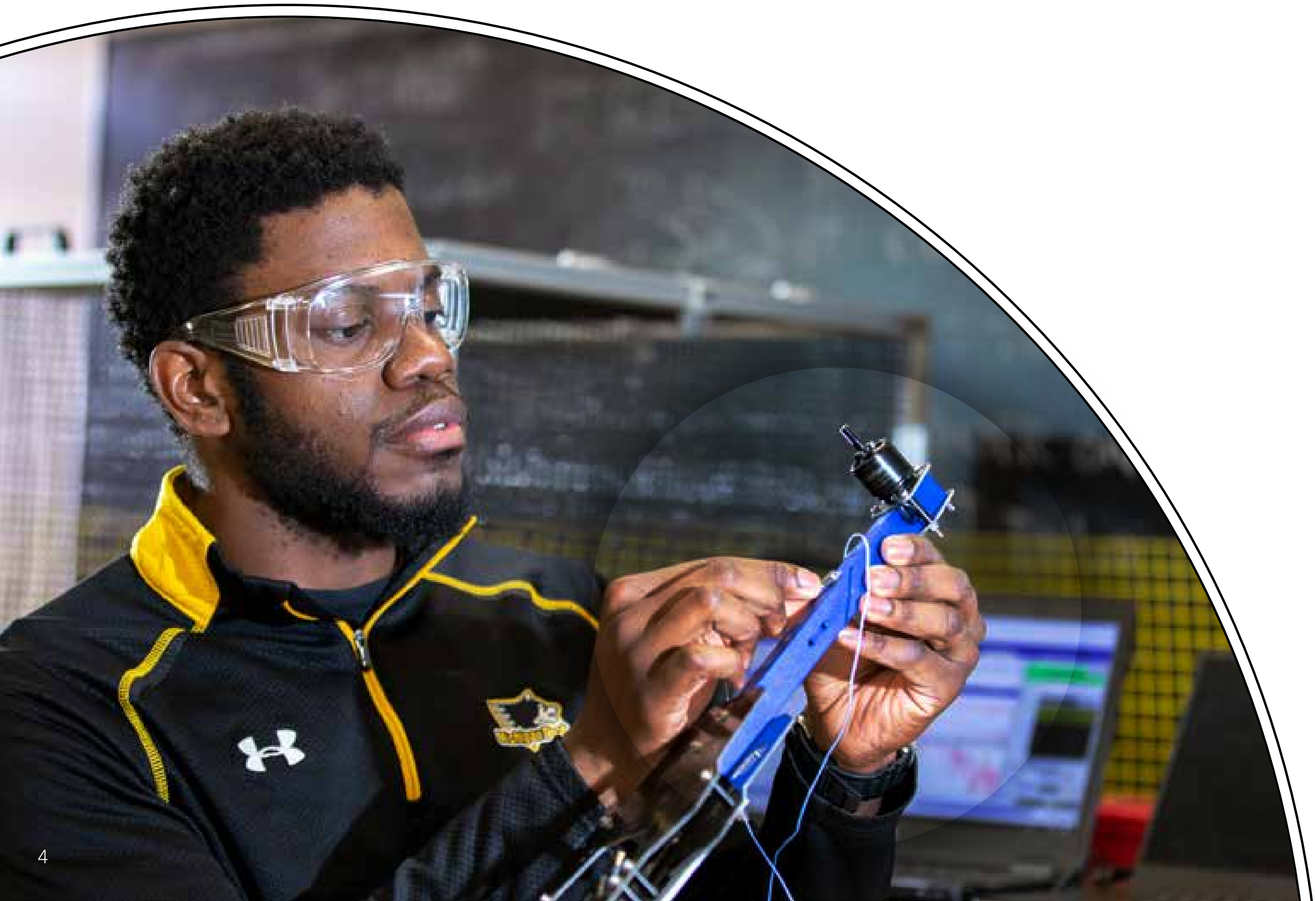


ELEMENT 1

THE MARKET FOR ENGINEERING

As the world of industry and trade have become more dynamic, with short design cycles for products and rapid obsolescence of many devices, it was recognized early on that our curriculum could not remain static. We needed to move with the world—to lead on change rather than follow.

By hiring faculty with industry experience and through feedback from the External Advisory Board (EAB), the ME-EM Department has kept its finger on the pulse of industry. Our relationships with alumni in the field have helped ensure faculty are preparing students with the skills and knowledge to serve as immediately contributing engineers when they begin their careers. Before we can lead with industry trends, we first need to ensure our sense of the market is well focused.



THE BEGINNING

In 1996, **Dr. Bill Predebon** recognized the need for this dynamic and let the Department know that he would only accept the position of Department Chair if there was a plan to revise the curriculum.

"Teaming with the faculty in the Department, I set a goal of implementing the revision by the fall semester of 2000 as we transitioned away from quarters and sought to reduce the credit loads to align with that shift. We wanted a cohesive curriculum consistent with ABET requirements," says Predebon.

The shift in curriculum began by exploring increased opportunities for hands-on laboratories, while decreasing course requirements, including the introduction of a combined thermodynamics course and the removal of a finite element analysis (FEA) and numerical methods programming course.

"During this process we created a stand-alone thermal lab, added a manufacturing lab, a mechanical engineering lab, and a controls lab," says Predebon.

Adding new labs created new challenges. Students needed spaces and equipment to conduct their lab activities. Predebon asked faculty to develop the labs and define what equipment was needed, while he promised to focus on fundraising initiatives.

Looking to facilitate the industry requests for team experiences, the faculty joined forces to integrate teams into lab exercises and in newly proposed, industry-sponsored Senior Design program projects.

"We wanted to provide students with industry-supported Senior Design projects that would allow them to work with industry partners on real-world problems. At the time, we had students take courses from various categories to meet their senior requirements, but we were lacking a true capstone experience."
—Dr. Bill Predebon

He met with many industry representatives who all agreed to support student education with $15,000 project sponsorships, even without knowing precisely what level of engineering return they would gain from the students in the new Senior Design program.

Raising $3.5 million between 1997 and 2002 as part of the Building for the Future campaign, Predebon and the faculty in the Department were able to fully equip four labs with industry-standard technology, provide Senior Design teams with spaces to meet, and also develop the Engineering Learning Center—one of the first on campus.

In order to further ensure students are always working with state-of-the-art tools, lab fees were introduced to cover new and replacement equipment.

"With the new lab spaces, our students went from canned lab experiments to fully embracing the open-ended, hands-on experiences we are known for," says Predebon.

RECOGNIZING THE NEED

In 2009, the faculty saw a clear movement in industry toward design workflows emphasizing simulation at the forefront. During the faculty retreat, Predebon asked the faculty *"Where do we take our curriculum next?"*

Dedicated to enhancing the educational experience of their students, the faculty started brainstorming ways to improve the curriculum through guided, direct application of engineering principles, building in opportunities for greater fluency in industry tools, expanding simulation and systems engineering, and providing the flexibility in senior technical electives.

Predebon gave the faculty an open-ended design objective to shape the curriculum as they saw fit. There were only two limitations: changes could not raise total credits required nor increase time to graduate.

The Curriculum Revision Committee was formed and began charting their course using ASME's Vision 2030, the NAE Grand Challenge, and national studies as their inspiration. In order to improve hands-on problem solving and to give students the opportunity to solve problems that matter, the committee envisioned four practice-based courses spanning sophomore and junior years that integrated content across concurrent classes.

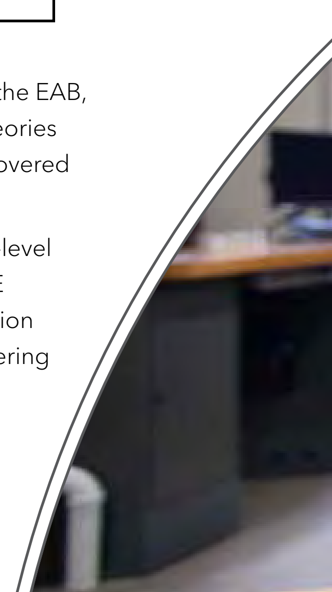
Following the proposal of the four practice-based courses, the committee began reviewing the degree flow chart to identify common topics and develop skills objectives for each course.

The list consisted of:

1. Application of Thermal Fluids
2. Application of Design & Manufacturing
3. Application of Solid Mechanics
4. Application of Dynamic Systems
5. Programming, Modeling, & Simulation
6. Instrumentation, Measurement, Controls, & Data Acquisition
7. Structured Design Process
8. Making & Tinkering
9. Communication & Collaboration

These topics were presented to the faculty, the EAB, and select students, who helped identify theories and applications within these topics to be covered in each of the four practice-based courses.

Once the committee agreed upon the high-level learning and skills objectives for the four ME Practice courses, planning and implementation was handed over to the Mechanical Engineering Practice (MEP) course coordinators.



Dr. Paul van Susante took the lead on MEP I, where the focus is put on discovering problems and solutions through reverse engineering, data acquisition, and one-dimensional FEA.

> *"They pick a consumer product and speculate on how it functions internally. Through the process, they learn about user needs, engineering requirements, and the design process."*
> *—Dr. Paul van Susante*

"Then, they take it apart to document how it actually functions, how it was manufactured, and review the assembly process.

Finally, they look at online reviews and pick an aspect of the product to redesign in CAD, based on customer feedback. Using their documentation, they have to reassemble it with no leftover parts."

Because the ME Practice courses are meant to build on one another, it is critical for the students to retain the concepts learned in each course, as they play a key role in the next course. MEP I introduces data acquisition by having the students measure something they can feel: elevator acceleration.

"We developed the ME Practice courses as a whole to build the skills of a mechanical engineer in a logical and time progressive fashion," says van Susante.

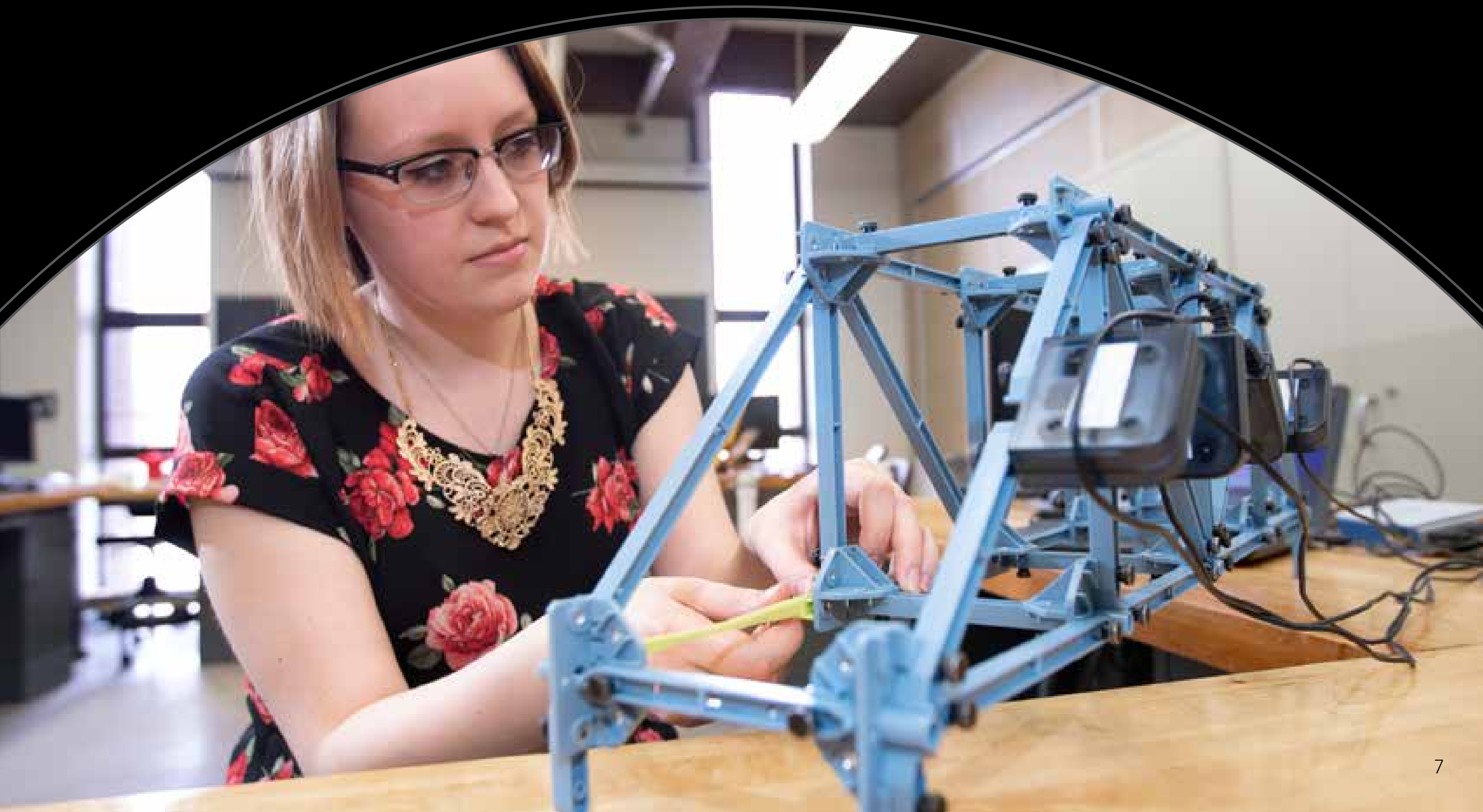
"We want the students to see how the courses they are taking connect. They can't compartmentalize the course and dismiss the information."

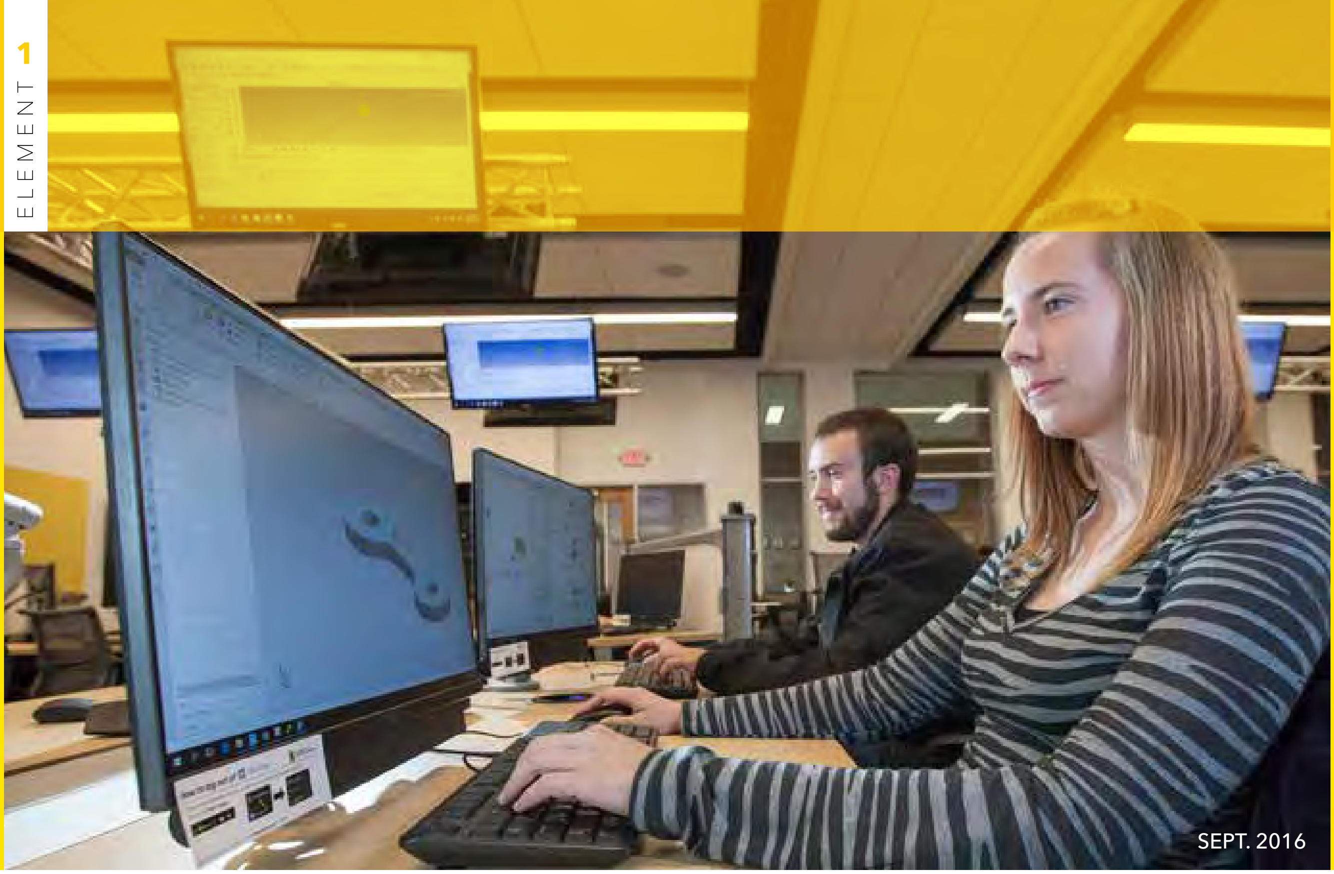
Following MEP I, students move in to MEP II led by **Drs. Jeff Allen** and **Jason Blough**, where discovery is at the core in building data acquisition skills, as are open-ended problems.

In this course, students use their knowledge of 1D FEA to work through 2D FEA design and validation, using a robotic arm mini-crane and an air handling system for a neonatal intensive care unit. These actions develop their foundational measurement skills with calibration and flow rate measurement; they witness first-hand how engineering effort can have a profound impact on others.

"This project emphasizes attention to detail. It's about more than just getting through the course; we shift their mindset from problem solver to problem analyst," says Allen.

> *"Students get to work on open-ended solutions where there isn't a single right answer. Through the process, they make mistakes without realizing it and then they learn to recover."*
> *—Dr. Jeff Allen*





As students transition from MEP II to MEP III between years two and three, they see a shift in the courses from discovery-based to direct application-based.

In MEP III, **Dr. Jim DeClerck** and Professor **Chuck Van Karsen** (now retired) prepare challenges to build out the students' systems engineering knowledge and increase their fluency with industry-standard simulation tools, focusing on 3D FEA, energy modeling, and rigid body dynamics.

Bringing together concepts of stress, strain, fatigue, deflection, energy, and circuitry, students build on the elevator models from MEP I and move according to a duty cycle over a specific length with predefined stops.

"We solidify the engineering design process while working in teams and connecting requirements. They look at their task, conceptualize the process, gather details, simulate, and show what the system will look like. They also do a complete design analysis of one of the parts in the system to understand how it feels to be on the job as an engineer," says Van Karsen.

The final ME Practice course challenges students in a highly collaborative environment while learning system integration, system dynamics and characterization, and controls under the direction of **Drs. Brad King** and **Jason Blough**.

The students build a cross disciplinary understanding through their work on a bicopter conducting drone surveillance for Tony Stark, pairing scenarios and equipment students can relate to with elements that excite them.

"We are teaching them to expand their toolbox of capabilities. It's about the synthesis tools, the techniques, the methodologies, data processing, and communication," says **Dr. Darrell Robinette**, MEP IV course instructor.

> *"We teach them to tell the story with a single plot; how to be a doer and a thinker at the same time. We are teaching them how to be effective engineers."*
> *—Dr. Darrell Robinette*

Due to the flexible nature of the ME Practice courses, course coordinators and instructors evaluate course effectiveness and modify them to meet the needs of the students.

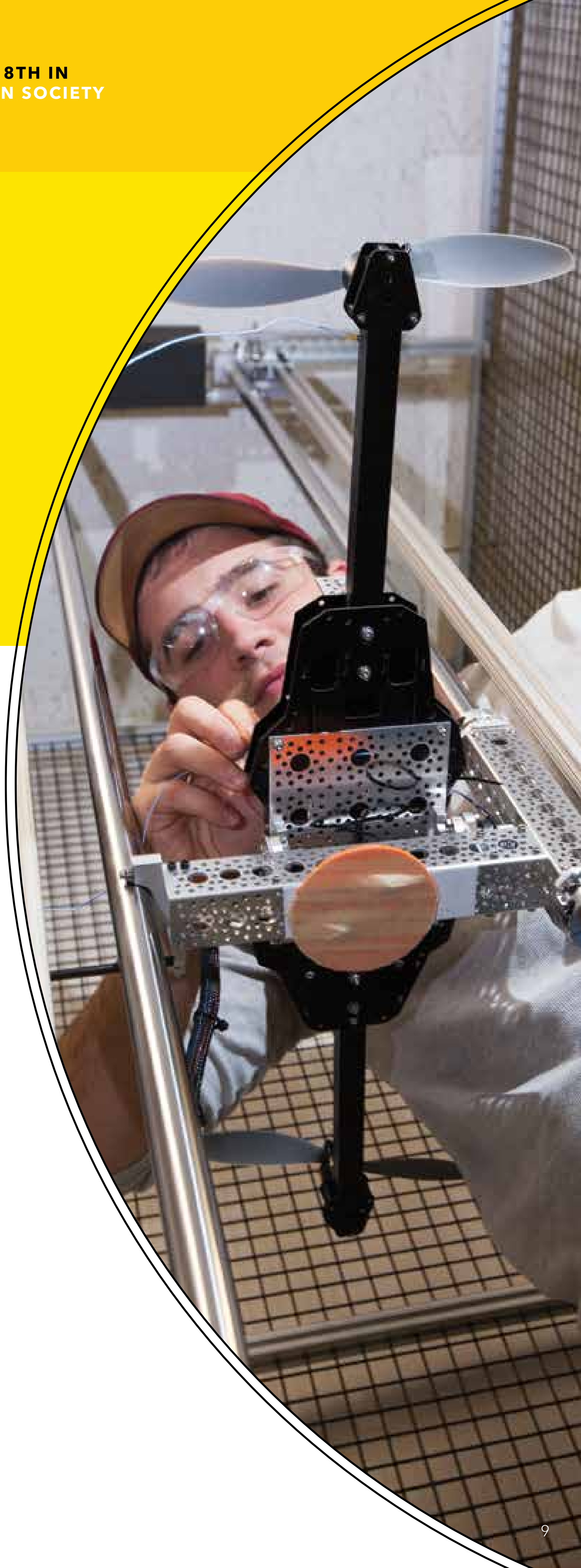
> *"With the open-ended nature of the courses, we tweak the challenges to improve the overall student experience. It's our own feedback control loop."*
> *—Dr. Jason Blough*

THE ME-EM DEPARTMENT IS RANKED 8TH IN BSME ENROLLMENT BY THE AMERICAN SOCIETY FOR ENGINEERING EDUCATION

The ME Practice courses were fully implemented in 2017 and replaced several labs within the Department, but the committee didn't stop there. They also needed to combine courses to align concepts and skills from the lectures translated to support the ME Practice courses.

This process began by combining Product Realization I and II to form Mechanical System Design & Analysis—a move that reduced credit requirements from six to three.

Mechanical Vibrations and Dynamic Systems and Controls were also combined to create Dynamic Systems, which changed the credit count from seven to four.



The course, led by **Dr. Gordon Parker**, prepares students for Senior Design by teaching them to solve for control parameters and also see the analogous principles between mechanical and electrical engineering.

The final credit shift from six to four credits came when the committee combined Fluid Mechanics and Heat Transfer to form Introduction to Fluid Mechanics and Heat Transfer. As part of this shift, the committee also developed a follow-up technical elective that pairs differential analysis and external flows in fluid mechanics and heat transfer.

Meeting their goal to increase opportunities for specialization or to broaden student skillsets, the credit reductions in combining courses creates flexibility for students to take additional technical electives.

"We increased their technical electives from three courses to five. This gave students the freedom to choose a focus area. They can specialize in one topic—like biomechanics, engines, or aerospace—or diversify with classes on five different topics."
—Dr. Greg Odegard

Additional courses were created and a move was made to include 4000-level courses across engineering departments, enabling students to build on their practical problem-solving skills.

ELEMENT 1

INDUSTRY 4.0

With ever-present industry contact, the faculty have perceived another need for a curriculum revision to include experiences with big data and machine learning.

"We need to lead the way with our educational programs and research into the fourth industrial revolution across the digital mechanical engineering space," says Predebon, who began encouraging faculty to consider a revision in 2018.

While the previous curriculum revisions were focused on the undergraduate level, big data, artificial intelligence, and machine learning encompasses both the undergraduate and graduate programs.

As director of graduate research studies, **Dr. Craig Friedrich** faces a unique challenge because graduate students do not have a defined curriculum, rather they take courses that either support their research or are of interest to them.

"We are focused on creating new courses related to the digital engineer, beyond the courses we already offer. Two years ago, we developed a certificate in Safety & Security of Autonomous Cyber-Physical Systems, which relates to electromechanical systems including power plants, dams, manufacturing plants, and vehicles."

"We focus on interconnected systems that need to be secured, building in intelligence to make them perceptive and smarter when they suspect a hacking event might be taking place," he says.

As part of the certificate, three new courses were developed to satisfy the certificate requirements and additional courses are in development.

"We have one new course being developed in probabilistic design in systems engineering, as well as a new course in the programming language python, a common and growing language in cyber security. In the fall we will have a new course on using python to simulate automotive systems and detect vulnerabilities," says Friedrich.

In addition, since the Building for the Future phase I ended in 2002, Predebon has shifted to phase II, Building for the Future: Endowing Excellence, which strives to hire new, diverse faculty with skillsets relevant to today's industry trends.

"We are hiring new faculty that have experience in swarm robots, coordinated robotics, and connected robots and are also working across departments to ensure our students have access to relevant courses," he says.

With these new courses and others in development, undergraduate students will see a benefit as they are also able to take these graduate-level courses.

"This is an expansion of our offerings to bring content into the curriculum, creating opportunities to build on our graduate student's capabilities," says Friedrich.

At the undergraduate level, the committee collected input from industry in the digital engineering space to understand the critical skills and knowledge gaps.

"We are educating students for current and future industry demands. When they graduate they need these skills, but in five years, their job may well migrate into some aspect of digital engineering and we are preparing them for that evolution."
—Dr. Craig Friedrich

5

THE ME-EM DEPARTMENT IS RANKED 5TH IN MSME ENROLLMENT BY THE AMERICAN SOCIETY FOR ENGINEERING EDUCATION

Four categories were identified:

1. Mathematics
2. Programming & Coding
3. Data Skills
4. Integration of Code, Data Science, & Fundamental Physics

"As we spoke with industry, we found a curriculum gap with linear algebra, statistics, and probability. Key concepts where our students were not as prepared as we thought they were. We needed to fill that gap in order for students to leverage the coding and programming elements," says Allen.

While the ME Practice courses were built to flex with the needs of the students, the materials presented in the courses were determined to be critical to their educational experiences and could not be further condensed to include machine learning and big data.

The committee realized these key concepts are more than just technical electives and sought to find a way to introduce the concepts to all students in the Department.

"We are shifting the curriculum at the 2000 and 3000 level, adding modules within the courses that would require the use of linear algebra, statistics, and probability," says Allen. "We are applying these concepts to a few key courses including Statics, Mechanics of Materials, and Thermodynamics."

Beyond increasing the mathematical skills, the committee is also looking at the optimal solution for developing logical problem solving techniques commonly developed through a programming course.

"At the present time, we do not have a structured programming language course within the curriculum, so we are looking next at the 3000 level courses and then at technical electives," says Allen. "We are superimposing these on the core courses in a way that fortifies the skills and knowledge."

The first phases of the modules will be implemented this fall with additional revisions rolled out over the next two years.

"The internal review was helpful in identifying places in our curriculum where students could be stronger and emphasized the importance of clear logic and critical thinking. We consistently hear industry say they want engineers to have the fundamental skills and knowledge. We are focused on activities that merge the concepts of big data and hands-on learning through existing courses, laying the foundation for what is real, with all the noise and artifacts, further preparing students for industry or graduate school," says Allen. "They won't be afraid of data and will learn to follow the signal within the noise."

As the faculty prepares to launch their curriculum revision and help students tackle challenges in Industry 4.0, they remain committed to retaining the key physical concepts and hands-on education that the Department is known for.

> *"Even in the midst of change, our students must be ready on day one. That's what industry expects of a Michigan Tech graduate."*
> *—Dr. Bill Predebon*

ELEMENT 2

DEVELOPING LEADERS

ME-EM graduate and undergraduate students are influenced by the research projects they are involved in during their time on campus.

Through innovative laboratories, collaborative enterprises, and experienced faculty, we help prepare our students with hands-on, project-based opportunities to build their portfolio with real-world projects.

DEVELOPING SKILL SETS

After a successful competition last year in the SAE AutoDrive Challenge, the team is making progress toward their goals for competition year three.

"At last year's competition, we took fourth place out of eight teams, which was a leap forward in terms of performance and execution of dynamic maneuvers," says **Dr. Darrell Robinette**, who advises the team through the Robotic Systems Enterprise, along with **Dr. Jeremy Bos**.

"At the next competition, the goal is to take a production level one vehicle that is normally human driven and transform it into an SAE level four, self-driving car with only limited human intervention."

The AutoDrive Challenge, sponsored by SAE and GM, aims to develop student skills in autonomy, fusing all sensors on board the vehicle with map and map data.

"In the next competition, the car will be ready for ride hailing–hitting waypoints, pausing to transfer packages, navigating autonomously by waypoints and maps—all while performing object detection and avoidance along the way," says Robinette.

While the team's progress has been slowed by the current pandemic, the graduate students involved in the Enterprise continue their work on virtual tools for autonomous vehicle development including artificial intelligence, neural net machine learning and classification, and preparing the code to put in place on the car for further testing.

The Robotic Systems Enterprise team has been able to simulate an autonomous vehicle in a virtual environment using MathWorks' Matlab software. Others in the group created an application for efficient route navigation within a city and then across states.

Together, Robinette and Bos guide students on effective vehicle autonomy through hardware and software development, sensors, coding, vehicle development processes, and vehicle dynamics.

The nature of full autonomy is complicated for both graduate and undergraduate students. However, helping students across the board in mechanical, electrical, and electrical and computer engineering develop core autonomous concepts is a key benefit for sponsors like GM, who are looking to foster these relevant experiences in the available workforce.

"Our students take a nebulous set of requirements and transform them into tangible engineering elements on a vehicle and then articulate that knowledge into a presentation for the competition."

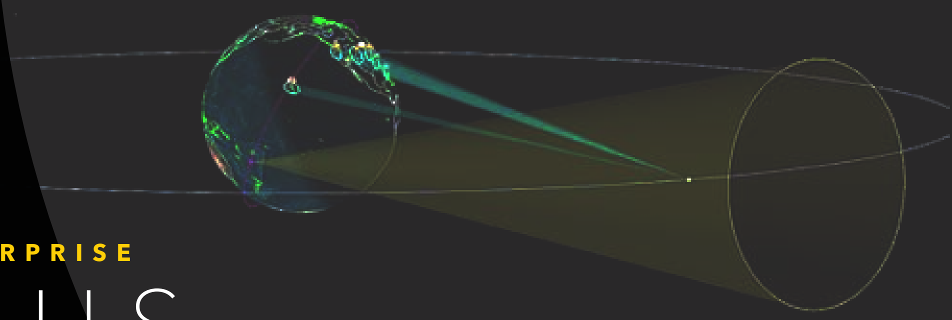
Through the competition, students leverage what they've learned in the classroom and apply it in a real-world scenario.

"We help students follow the processes that break down complex systems into robust requirements, following the "V" diagram for engineering, and then lead them through validation and verification to showcase overall performance. In the competition, we are guiding engineers on becoming engineers," he says.

Looking toward the future, the competition will likely wrap up next spring due to delays with COVID-19; however, SAE has published a request for proposals for AutoDrive II with a planned kickoff in fall 2021.

“We would love to submit a proposal and use that platform to further enhance our students’ understanding. It follows our mission of building the next generation of ready-to-contribute engineers,” says Robinette.

> *“The talents developed during this competition ultimately bring value to SAE. It’s also led to great opportunities for our students. Several have already been recruited for jobs as a result.”*
> *—Dr. Darrell Robinette*



AEROSPACE ENTERPRISE

OCULUS

A longstanding tradition of hands-on, real world experiences has developed in the Aerospace Enterprise under the direction of **Dr. Brad King**. Undergraduate students have risen to cascading challenges and established a robust, sustainable organization. Last year, we reported on the Oculus-ASR, a student-built nanosatellite that was carried on the first payload launch of the SpaceX Falcon Heavy.

"The Oculus incorporated work from over 800 students since the team's inception in 2004 and undertook a nine-month mission to act as an imaging target for ground-based cameras of the Department of Defense, improving the classification of satellite behavior," says King. "The data portion is complete and it met its mission objectives. It will likely be in orbit for five to 25 years and students expect operational integrity for one to three years."

JUNE 2017

AEROSPACE ENTERPRISE

AURIS

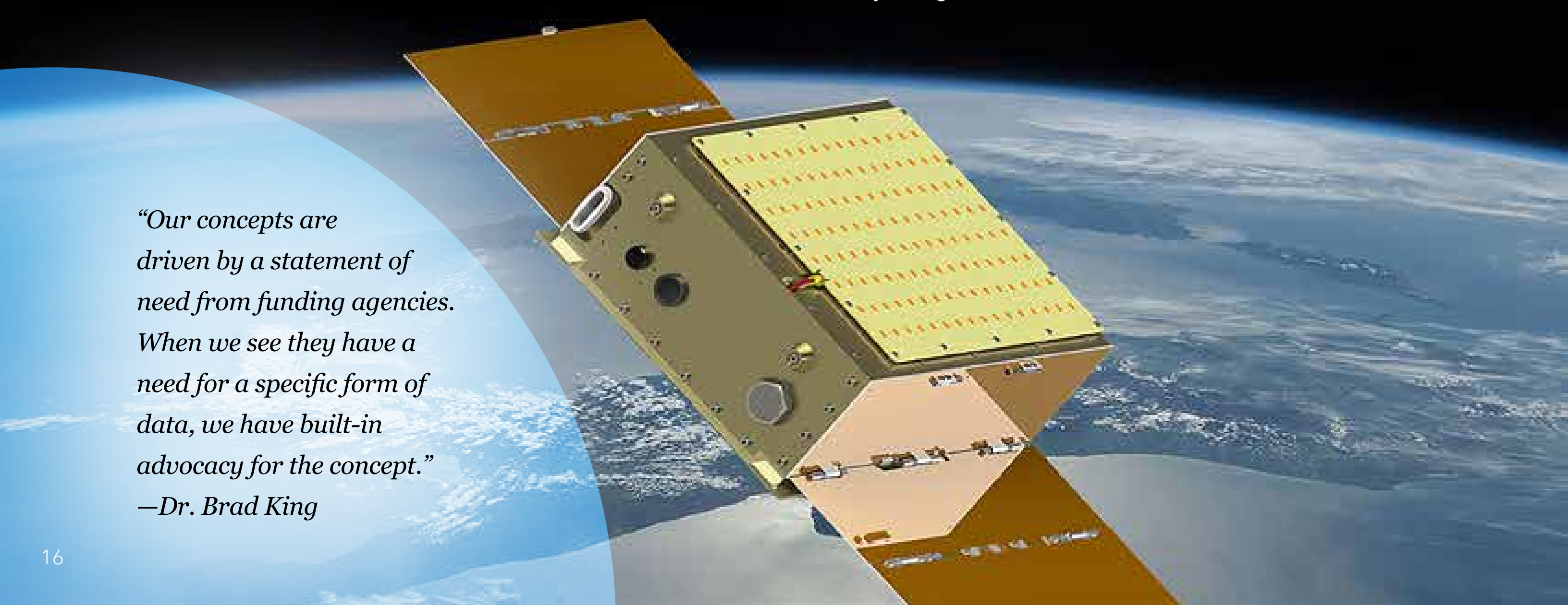
Another satellite in the Aerospace Enterprise, Auris, is taking shape with funding from the Air Force Research Lab University Nanosatellite Program.

"We have cleared the system concept review in the design and development phase and are now competing against 10 universities for the final one or two satellites that will be funded for launch," says King. "The competitive selection will take plan in January 2021. If our students' design is selected, we are awarded a follow-on contract from the current state to complete all launch-ready requirements."

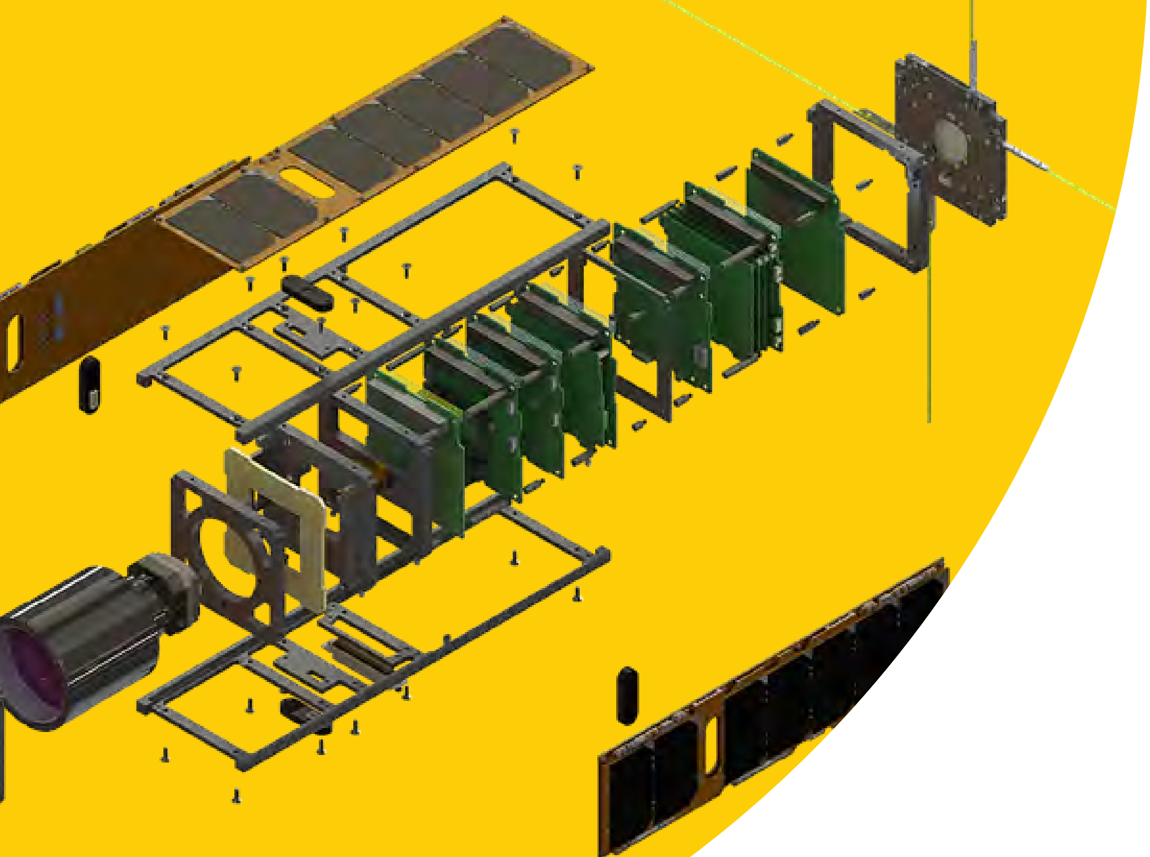
The concept behind Auris came about through discussions with an alumnus of the Aerospace Enterprise and the concept of utilizing a small satellite to monitor communications from other satellites.

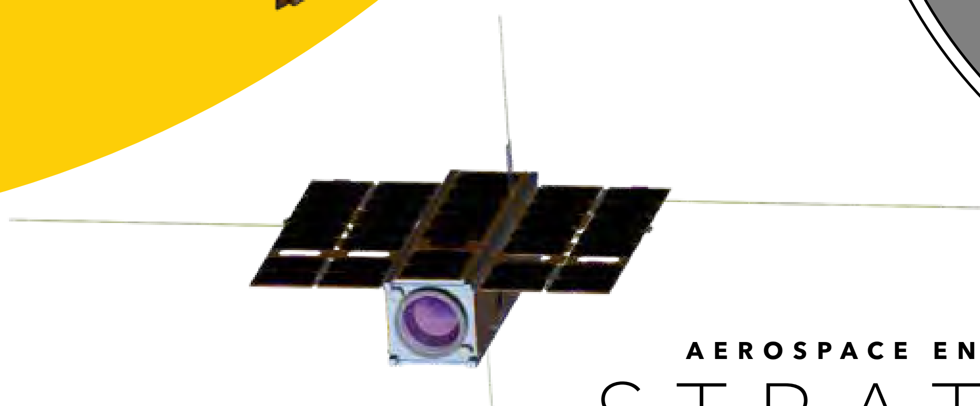
Auris is a 'listening' satellite that will develop a heat map to measure the strength of radio signals transmitted toward earth as a function of time and global position.

"This will enhance policing around geographic dispersion of satellites, ensuring satellites are operating under the frequencies they have been approved to use," says King.



"Our concepts are driven by a statement of need from funding agencies. When we see they have a need for a specific form of data, we have built-in advocacy for the concept."
—Dr. Brad King





AEROSPACE ENTERPRISE

STRATUS

Following the success of Oculus, the Aerospace Enterprise team has been developing other opportunities for spacecraft that would have value for funding agencies.

"After reaching out to our network, we saw potential for NASA's Goddard Space Flight Center to enhance their climate monitoring mission with a satellite that can determine cloud height and cloud top winds," says King.

"We developed a requirements and capabilities document and combined that with Goddard's statement of need."

Following their proposal, the group received funding through NASA's Undergraduate Student Instrument Program and CubeSat Launch Initiative. The satellite, in keeping with Latin names, was deemed Stratus and utilizes a mid-wave infrared imager to validate and improve weather models.

"If you take a number of images from the same cloud region over a span of minutes, you capture the evolution of the clouds to determine how they moved–ultimately providing a 2D map of the wind vector field," says King.

Once in space, the satellite will partially process its imagery.

"The rudimentary processing will be completed on board and the satellite will send down sparse data sets. Communication will take place using a global network of antennae connected to an IP address students can easily access from a computer, through a partnership with Atlas Space Operations based in Traverse City," says King.

The data from Stratus will create opportunities for students to write and publish papers with guidance from NASA and also serve as a collaboration tool for weather researchers to interpret and further share information.

MINING INNOVATION ENTERPRISE

LUNABOTICS

Further enhancing aerospace opportunities, **Dr. Paul van Susante** has worked with the Mining Innovation Enterprise students and summer research students on two lunar-based competitions.

"In the first competition, 50 US university teams were selected to build a robot that can excavate. Starting on one side, the robot must drive over rocks and craters, excavate, drive back to the lander, and dump the excavated material," says van Susante.

"In previous competitions, whoever excavated the most material won, but they have since added requirements on dust tolerances, energy usage, and communication bandwidth."

The team conducted careful designs using system engineering to optimize the system height, dust filtering, sensors, and transport process.

"We designed our system but needed to cut weight to meet the 60 kg mass requirement. The team redesigned several items, such as replacing metal rollers with 3D-printed conveyor rollers and transport buckets to achieve an overall 40 kg final design," says van Susante.

"The competition was scheduled to take place at the Kennedy Space Center, but was cancelled due to the COVID-19 pandemic. We are hopeful we will get to present our design in the competition next year."

The team will build the fully designed robot and begin testing in the fall 2020 semester.

MINING INNOVATION ENTERPRISE

NASA BIG IDEA COMPETITION

NASA's Big Idea Competition funds student-based university research projects that advance the mission of getting back to the moon. "We developed a proposal to support exploration of permanently-shaded moon regions using a tether to convey energy and data. The system name is T-Rex, and was one of eight university designs to receive funding to build and test the system," says van Susante

"Striving for a technology readiness level 6, we will be deploying a superconducting cable from a visible lander station down into a permanently shaded region of the moon, where direct line of sight communication to Earth isn't possible and solar power is unavailable. T-Rex is a team player and would serve as a local wireless communication point, giving other robots a place to dock, recharge, and communicate through the tether up to the lander and then back to Earth."

The initial design and proposal was created by Senior Design students and was built over the summer by 11 full-time students: two graduate and nine undergraduate students. Once the system is built and ready to be tested, students will deploy T-Rex into a special thermal vacuum chamber on campus that supports a dusty, moon-like environment. Results of the tested system are scheduled to be presented at the NASA BIG Idea forum.

These projects challenge students with a complex problem and provide an exciting opportunity to design and build the solution. "We build the research tools while setting a mindset that will branch out beyond their time on campus and fuel their career contributions," says King.

Through these Enterprises and competitions, the ME-EM Department stays true to its mission.

"We aren't just producing a product; we are producing highly capable individuals through hands-on research and development."
—Dr. Paul van Susante

TEACHING EXCELLENCE

While couched in the challenges of budgets and schedules, teaching is the central element of human progress. When it is done well, students and administrators join forces to recognize faculty who go above and beyond. While it's no race, it does require endurance to maintain excellence.

This was the inaugural year for the Provost's Award for Sustained Teaching Excellence, which honors faculty who have been nominated as finalists for the Distinguished Teaching Award four or more times.

"It became clear that we had a group of instructors delivering exceptional instruction to their students over many years, who are worthy of special recognition," says Provost Jackie Huntoon.

Dr. Gordon Parker was among the first faculty at Michigan Tech to receive the award.

"I am extremely fortunate to have found my calling early—I'm passionate about engineering and I try to excite that same passion in my students," says Parker. "When getting ready to teach, I put myself in my students' shoes, making sure I'm getting the information across in a way that is meaningful and helpful to them."

In all of his classes, Parker follows the teaching principles he has established and adapted in his 24 years of teaching.

THESE PRINCIPLES FOCUS ON:

Performance – adding value online and in the classroom.

Knowledge – providing learning opportunities in and out of the classroom.

Beauty – communicating the beauty of every topic.

Technique – trying new teaching methods and technology without endangering learning outcomes.

Stereotyping – never assigning traits to groups of students.

Respect – respecting each student and expecting similar in return.

Fairness – evaluating student performance in a fair manner.

Preparedness – being prepared for lectures. Never leaving problems half-solved unless it's a planned exercise.

Relevance – relating content to current events, connecting to what students have done and will do in the future.

Expectations – maintaining high expectations; communicating learning outcomes and expectations early and often.

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THE ME-EM DEPARTMENT IS RANKED 26TH IN PHD ENROLLMENT BY THE AMERICAN SOCIETY FOR ENGINEERING EDUCATION

While Parker realizes the students are a captive audience with a curriculum and structure in a class they are required to be in, he focuses on maintaining respect and providing them with information beyond what is available in textbooks.

> *"Exciting their imaginations about what they can do with this in their future and then hearing back from them when they've started their careers is a huge motivator."*
> *—Dr. Gordan Parker*

While Parker didn't begin his career expecting to teach, it was a passion he soon discovered while working at Sandia National Laboratories, presenting information he found exciting. "That's how I teach all of my classes now—preparing them to walk away with enough information to continue learning here or later in their careers," says Parker.

In addition to the Provost's Award for Sustained Teaching Excellence, Parker was further recognized as the ME Teacher of the Year; an award voted on by students and organized through the Mechanical Engineering Student Advisory Committee.

> *"Receiving this award was incredibly touching. It's voted on by our students, and I really had no idea they felt this way, but to see their comments was a humbling experience. I'm glad to be able to work with them and lucky to know that it's having an impact," says Parker.*

Aneet Narendranath was also recognized, alongside Parker, as a finalist for the ME Teacher of the Year award. He has been a lecturer in the Department since 2015, teaching courses at the sophomore level up to the graduate level on topics ranging from statics to thermodynamics, mechanics of materials to heat transfer, the new ME Practice courses, finite element methods, computational fluids engineering, and advanced fluid mechanics. "Narendranath has a passion for learning and that passion comes through in his teaching. He is a thoughtful and dynamic instructor with groundbreaking and inspirational ideas that serve to enhance the educational experiences of the students in his classes," says Dr. Bill Predebon.

REDEFINING ENGINEERING

Focused on shaping and training the next generation of engineers, **Dr. Sheryl Sorby** has taken the helm as the president of the American Society of Engineering Education (ASEE). Sorby began her career at Michigan Tech in the ME-EM Department in 1986 teaching graphics to first year students, before volunteering to learn and teach a new senior-level course in computer aided design (CAD).

"Shortly after my first year teaching CAD, ASEE had a section meeting in Houghton, so I attended and submitted my first publication on teaching CAD. I became engaged in the organization at the section level, but my involvement really took off after receiving a grant from the National Science Foundation in 1992, which centered on helping students develop 3D spatial visualization skills. As part of the grant, we had to share the results, which we did at the annual ASEE conference. From there, I started to go to the conference annually."
—Dr. Sheryl Sorby

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THE ME-EM DEPARTMENT IS RANKED 19TH IN BSME DEGREES AWARDED BY THE AMERICAN SOCIETY FOR ENGINEERING EDUCATION

Since attending her first conference, Sorby has participated in ASEE at the section, division, and national level—holding multiple positions on boards and igniting her passion for advancing engineering education.

> *"The more involved I got, the more I realized I had a voice to be heard. I could help move engineering education forward, especially as ASEE president," says Sorby.*

Educational institutes have already started to look inwards at ways to adapt with the move to online instruction and labs during the current pandemic. "Now is the time to reinvent ourselves. Curriculums for engineering haven't stressed creativity. We are good at replicating ourselves, but that's a problem. We need to transition away from mass production of engineers through a rigid curriculum," says Sorby.

While universities are accredited, the accreditation board doesn't lock a curriculum into specific courses, so Sorby hopes institutions will become more creative in how they meet the requirements.

"On paper, ABET says we need three semesters of math and science, but they do not say you need specific courses for math and science. We have evolved into a rigid system over the years. It's going to take work on everyone's part because we all matured within the system," says Sorby.

Openly admitting this change will be difficult, Sorby says it is time to go back to the root of engineering—focusing on creative thinking, trying new things, and improving on solutions.

"We need to step back and say it is the year 2020. We need to look at what our students need today, not what they needed in a previous generation. We have to optimize the system with the goal of opening it up to more kinds of minds."

After serving as president-elect for the past year and beginning her role as president on June 28, she has already formed a committee of creative engineers.

"We are looking at what we are doing now and why and will be coming out with a recommendation in terms of what the curriculum should look like moving forward. We seek to redefine who engineers can be, shifting away from the narrow, analytical approach of the past to developing creative problem solvers through a novel, scalable curriculum: Re-envisioning the Curriculum for the 21st Century: Pathways to Engineering."

Sorby hopes the shift away from the rigid curriculum will also open the doors for greater diversity.

> *"We need to move away from thinking of engineering education as a pipeline, which implies there is only one starting point. There are many pathways to engineering and we need to remember that as we work, the pendulum will shift," says Sorby.*

Once Sorby wraps up her role as president, she will transition to past president and hand the gavel to Dr. Adrienne Minerick, Dean of the College of Computing at Michigan Tech.

"I am thrilled she is following me as president-elect and then president of ASEE. She is a reliable leader and is insightful and visionary. I look forward to working with her for the next two years on the board," says Sorby.

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THE ME-EM DEPARTMENT IS RANKED 16TH IN RESEARCH EXPENDITURES AMONG ALL MECHANICAL RESEARCH IN THE US BY THE NATIONAL SCIENCE FOUNDATION (NSF)

MAKING WAVES

Developed in a sweet spot with both state-of-the-art instrumentation and a high level of affordability, the wave tank on the Michigan Tech campus is increasing research opportunities on campus and with industry.

The three meter wide by 10 meter long tank with eight paddles to generate waves has been outfitted with an 11-camera Qualisys system for motion tracking of up to 50 rigid bodies in the tank. Wave gauges have also been added to resolve the water surface down to the submillimeter range.

"These additions allow us to understand what the water is doing and give us full knowledge of the system," says **Dr. Gordon Parker**, John and Cathi Drake Chair Professor of Mechanical Engineering.

Since the wave tank opened, it has had several customers take advantage of the repeatable, controllable conditions to validate physical models.

Several proposals have also been submitted where the wave tank will serve as the primary research tool, focusing on flexible body hydrodynamics, wave energy converter (WEC) array control, and single WEC control.

Three additional faculty members at Michigan Tech are utilizing this advanced research tool.

Dr. Wayne Weaver is developing advanced control strategies to improve energy extraction from both single and multiple WECs working in harmony.

Dr. Hassan Masoud is using the wave tank to explore fundamental concepts of hydrodynamics, while **Dr. Yongchao Yang** is looking at machine learning strategies using WECs to estimate the wave field.

> *"One Senior Design project could have an impact on our WEC program. Students are building a WEC with an open control architecture and an experimentally proven model."*
> *—Dr. Gordan Parker*

"It is unique because it will be accessible remotely to students and researchers around the globe who are exploring WEC modeling and controls without access to a wave tank," says Parker.

"They will be able to obtain the WEC model, develop their control strategies in simulation, and then test and collect data using our wave tank."

An additional feature of the student-built WEC is that it will be wireless.

"Often WEC models have wires connecting them to on-land computers, introducing parasitic forces. With this set-up, we can put the model in the water and avoid it being disturbed by these types of parasitic forces entirely," says Parker.

The ultimate goal of this Senior Design project is to further expand the reach of the wave tank beyond campus to gain external exposure.

"The model will let others participate in WEC research through open source wave tank control," says Parker.

Supporting the Senior Design team on their development of the wireless WEC controller to ultimately expand the reach of the wave tank without external funding is made possible through Parker's role as the John and Cathi Drake Chair Professor of Mechanical Engineering.

"Their generous endowment and support offers me the flexibility to develop these auxiliary technologies to enhance student experiences and the potential of the wave tank. Without the Drakes, this would not happen," says Parker.

ELEMENT 3

STRENGTH IN NUMBERS

The presence of University-based and national research centers and institutes on campus ensures students are able to actively participate in advancing the state-of-the-art for their particular area of interest.

THE RISING TIDE

> *"The easy challenges were met long ago. We need larger teams to overcome greater problems."*
> *—Dr. Bill Predebon*

The culture of collaboration within the ME-EM Department, and across the Michigan Tech campus, has led to the success of several research centers/institutes with six centered in the ME-EM Department or having leaders based in the Department.

This collaborative culture was fostered as a concept through the formalization of research caucuses within the ME-EM Charter, which were formally adopted in 2006. The discussions centered around team research proposals, encouraging faculty to apply for joint proposals, and ultimately leading to larger projects and grants.

"The research caucuses eventually dissolved after we all started thinking that way, having meetings with colleagues, and putting in place patterns for collaboration and applications for larger grants," says **Dr. Greg Odegard**, director of research.

"The current administration across campus has been forward-thinking in their support of a University-wide collaborative approach for grant applications."

[redacted]

The same shift taking place on campus is also taking place at the funding agency level. Agencies, including the National Aeronautics and Space Administration (NASA), Department of Energy (DOE), Department of Defense (DOD), and National Science Foundation (NSF), have found that solving challenging problems with critical technology is improbable without a large and diverse team of researchers.

"Fully integrated solutions require closing many different kinds of gaps. A small team may only solve one aspect, leaving the solution incomplete," says Odegard.

The Department currently houses Ultra-Strong Composites by Computational Design (US-COMP), a NASA-funded institute, which is the largest single grant the University has ever received.

"Some problems are too difficult to solve with small grants. For example, with US-COMP, NASA realized no single university could fully develop the advanced materials needed for deep space exploration," says Odegard.

Two additional proposals are in place, including an NSF-funded Engineering Research Center and a DOE-funded WASTE Center.

"With the WASTE Center, trying to find a way to take recycled plastics and reformulate them chemically into a new, useable plastic in an efficient and inexpensive manner is a tremendous challenge.

These problems require a large, distributed team with gravitational pull big enough to draw the nation's top experts," says Odegard.

"We need to get a lot of people together, brilliant minds, to form a center or institute to solve the problem, and we're seeing that trend on campus."

In order to encourage collaboration and the shift to larger research centers, the Department has maintained their support of faculty through staff, who help to facilitate the proposals as well as align faculty and staff in the direction of desirable proposals at a strategic level.

But the centers and institutes within the Department have an impact beyond the research.

At the undergraduate level, these centers provide students with priceless experience and instill an excitement for science, technology, and engineering, while introducing the possibility for research-based graduate studies.

"The greatest impact is with graduate students. We are training the next generation of researchers, who will enter industry or academia ready to move science ahead," says Odegard.

"Graduate students get an opportunity to conduct research as a critical part of the team, collaborate with external and industry partners, and get their name in publications, proposals, and presentations."

The faculty involved in the research become masters of their domain and that passion translates into the classroom.

"When faculty members talk about their research as examples in class, the students sense their excitement. Students come back to the faculty to find out about opportunities to work on the research, which can lead to graduate school," says Odegard.

MISSION: SPACE

Manned missions to the moon or Mars face the daunting challenge of producing fuel and oxidizers in these inhospitable environments. The need for propellants to get back to earth is the weighty challenge set before **Dr. Paul van Susante**. He has two funded research projects aimed at eliminating the need to bring liquid oxygen and hydrogen for propellant, enabling manned space missions to carry increased useful payload.

WATER FROM ROCK

Using a combination of applied research and technology development, the first project is in the final stages of a three year scope and explores how to harvest water from gypsum rock. If successful, the system will extract water from hard-rock gypsum using a water jet system to abrade the solids into a slurry of gypsum particles that can be heated to extract water.

> *"We are wrapping up lab experiments and then we'll conduct final testing in the vacuum chamber. The pieces are feasible, so we are developing ways to make them operate seamlessly."*
> *—Dr. Paul van Susante*

One challenge the team has faced is finding commercially available components that are properly sized to mimic the needs of a small space mission. "We understand the relationship between water and pressure, but are still working to adapt the commercial systems to meet our smaller scale needs," says van Susante.

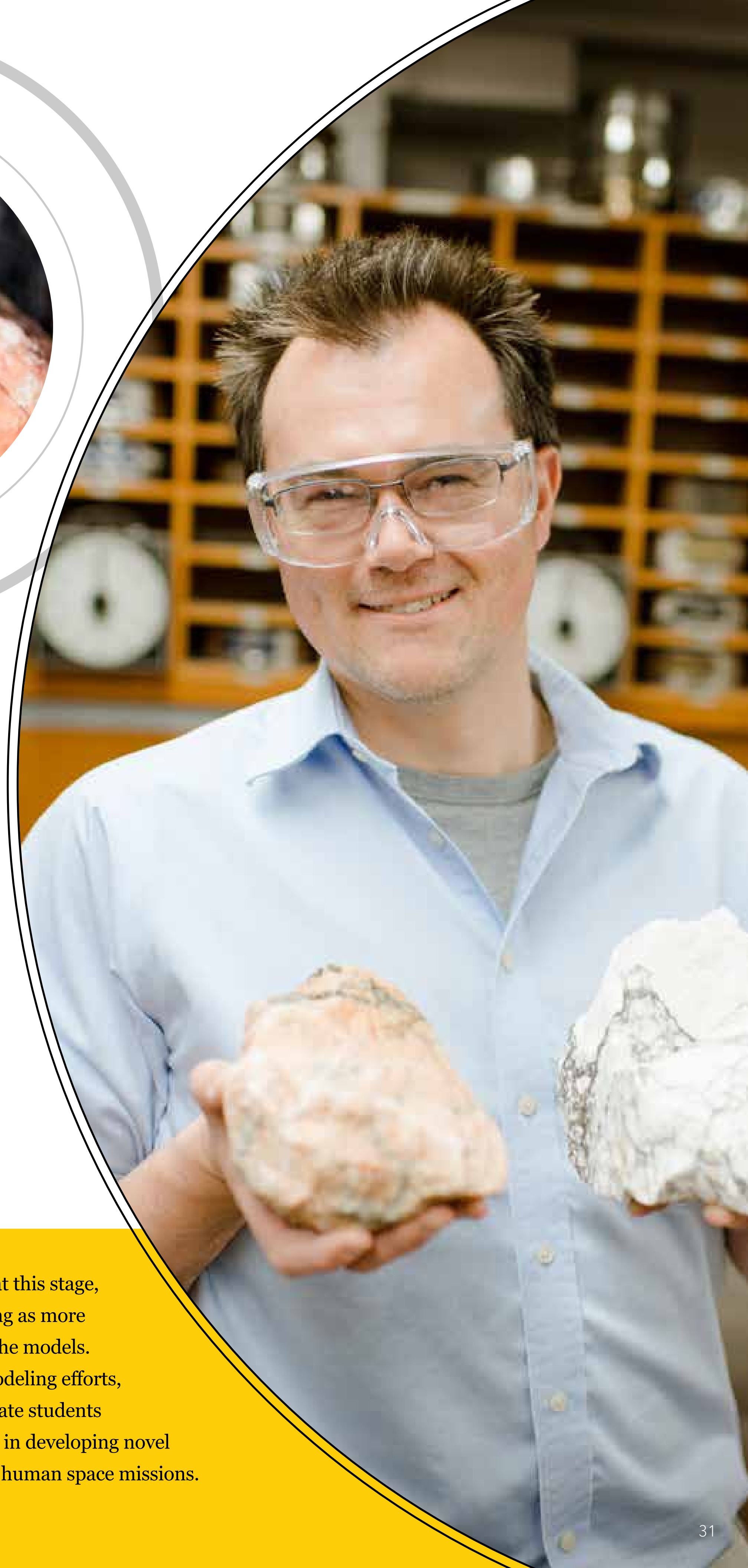
While the system is water jetting, there is a required suction component to collect and process the rock particles. The team's solution has worked well under certain conditions and is still being explored during the water jetting process to ensure efficiency.

"We are to the point where we seek to elegantly integrate the system at a much higher quality level," he says. "The current project has a low technology readiness level (TRL) 4—on a scale of 1-9—at the end of the project, with the intention of moving toward a TRL 5 or 6 if the pieces can be further developed with follow-on funding."

The project team includes one PhD student with help from both graduate and undergraduate students performing design iterations, each improving upon the last. Once ready for testing, the system will move into a simulated Mars environment, where they anticipate their greatest challenge is likely to be energy efficiency and performing suction at the lower atmospheric pressures found on Mars.

WATER FROM ICE

The second project is at TRL 6, requiring a fully built-out system tested at relevant conditions, to extract water from buried glaciers on Mars. "Following a method used in Antarctica to create a well for drinking water, the goal is to drill through the dust and rocks on top of the glaciers on Mars, continue drilling to a defined depth, and then melting and harvesting the water," says van Susante of the three and a half year project that is in year one.



As a subcontractor under Honeybee Robotics, van Susante and his team are focused on measuring how well a probe would melt the ice and determining the overall effectiveness of the approach.

"We are looking at the various geometries of the probe on a benchtop scale with a six inch probe melting into a block of ice that is eight inches tall inside a vacuum chamber that is 18 inches by 18 inches," he says.

"We are drilling thermocouples into the ice and refreezing around them. Then, we are melting the probe into the block, sending it straight down to determine melt speed and energy under various atmospheric pressures and ice temperatures."

While the project is all experimental at this stage, van Susante plans to conduct modeling as more empirical data is collected to anchor the models. Students would also support these modeling efforts, giving both undergraduate and graduate students first-hand experience, involving them in developing novel solutions and advancing the future of human space missions.

ADAPTING FOR FUTURE MOBILITY

Coming directly from industry, **Dr. Darrell Robinette** has experience in the world of mobility following nine years with General Motors. He joined the faculty in 2016 and has focused his research efforts on drivetrain dynamics, torque converters, propulsion system electrification, and connected and automated vehicles.

When Robinette was hired, he had a vision of building a test cell capable of adapting to the ever changing needs of research, but remained focused on vehicle drivetrain, propulsion, and energy management.

Through support from General Motors, Ford Motor Company, John Deere, Borg Warner, and Millbrook Revolutionary Engineering, his vision was realized earlier this year.

"With the new Advanced Drivetrain and Propulsion Technologies (ADAPT) Test Cell, we are able to test everything from individual propulsion system components all the way to a full vehicle in the test cell and have it behave like it is on the road."
—Dr. Darrell Robinette

"The mobility industry is undergoing a dynamic transformation and Michigan Tech has to be ready to adapt to those changes with our research facilities. This new test cell achieves that goal," says Robinette.

The ADAPT test cell will bring additional flexibility to APS Labs, allowing researchers to beam in virtual traffic profiles and traffic scenarios for connected and autonomous vehicles, where testing is often a challenge.

"We can bag a set of real-time sensor data from human driving in ideal and harsh winter conditions and then play them back in a vehicle installed in the test cell using automated control to see the performance," says Robinette.

He is also part of the NEXTCAR team at Michigan Tech that received funding from the US Department of Energy's Advanced Research Projects Agency-Energy (ARPA-E) to reduce energy consumption by 20 percent in light-duty hybrid electric vehicles.

The team currently operates five fully instrumented vehicles in their connected vehicle fleet on a 24-mile test loop in the Houghton-Hancock area that incorporates city, highway, rural, urban, and elevation changes to conduct maneuvers in specific traffic scenarios.

The NEXTCAR team is focused on exploring real-world drive cycles to show the highest applicability and determine the energy savings possible by having the vehicle adapt its routing plans and controls based on vehicle-to-vehicle (V2V) and vehicle to infrastructure (V2I) inputs.

"The NEXTCAR project has been rewarding. Trying to achieve a 20 percent energy reduction from an existing vehicle is daunting, especially when a new engine program will only net you a small percentage of improvement in efficiency."

> *"To come in and show that with all the connected vehicle data we are able to move the bar in a major way is a great accomplishment. We've achieved the 20 percent reduction, and are now examining the range of conditions where we can sustain that margin, and in which conditions we capture smaller improvements, like steady-state cruising on flat terrain," says Robinette.*

Looking forward to additional connected and automated vehicle research projects, the new ADAPT test cell enables researchers to take some of the vehicle testing off the road and run a range of virtual traffic and infrastructure scenarios, alter vehicle road load profiles, safely verify custom automated control features, and run energy consumption repeatability tests without leaving Houghton or going out of the lab in the winter.

Testing performed in the ADAPT test cell is similar to chassis dynamometer facilities and provides a controlled environment for energy consumption and repeatability.

"The ADAPT test cell will be a boost to our testing program during our extended winters that can sometimes be prohibitive to repeatable measurements," he says.

RAISING THE BAR

As we look forward into the future of energy in the US, there are three major areas of concerns: energy efficiency, America's dependence on vulnerable energy sources of imported oil, and climate change.

Since joining Michigan Tech in 2016, **Dr. Sajjad Bigham's** research lab, Energy Exploration Laboratory (Energy-X), has largely focused on knowledge gaps and technological barriers pertinent to these three areas. These challenges are often interwoven, thereby requiring energy solutions that are efficient, sustainable, and affordable.

One of the profound aspects of the above energy-climate dependency is in the air conditioning area.

> *"By 2050, the number of worldwide air conditioning systems will triple. Every second for the next 30 years, 10 new AC systems will be sold. We'll need to generate power for that many systems, while remaining energy conscious."*
> *—Dr. Sajjad Bigham*

"This requires new energy infrastructures, as the upcoming energy burden could warm the planet as much as 0.4 to 0.8°C by 2050, accounting for 20 to 40 percent of the world's remaining carbon budget."

The unfortunate part is that many of our electric power plant generation facilities are 40 to 50 years. Drawn to this challenge, he secured a $2.4 million grant from Department of Energy's (DOE) Advanced Research Project Agency-Energy (ARPA-E).

"Our goal is to advance science and develop components required for future energy-efficient power plants. One plausible pathway is to change the working fluid of power plants from a sub-critical fluid to a supercritical one.

This means we need to move toward technologies that can sustain high temperature and high pressure (HTHP) above 1100°C and pressure between 80 to 250 bars. Current power plants operate at only 560 to 570°C. The goal is to transform current steam Rankine cycles with a thermal efficiency of about 34 percent to supercritical Brayton cycles with thermal efficiencies well suppressing 40 percent and nearing 50 percent, depending on the maximum temperature operation," says Bigham.

He and his team have turned to the additive manufacturing process to 3D print a monolithic sintered silicon carbide (SSiC) heat exchanger. The current technology cannot produce the high-density SSiC materials required for HTHP heat exchangers. In addition to the team at Michigan Tech, the grant also brings together partnerships from Oak Ridge National Laboratories, as well as three companies with expertise in material processing, 3D printing, and heat exchangers.

> *"We're honored to receive this project. Being a high-risk, high-reward project, it has certainly broadened our horizons. We presented a solid concept with a competitive team and are currently working on an aggressive timeline with little room for error," says Bigham.*

One of the biggest challenges the team is facing is the work with a ceramic, powder-based material in additive production. "We are aiming for high density and high quality in our processes and have to watch carefully for rheology and sintering, which can create voids in our materials," says Bigham.

"After challenges in the first quarter with permeability and density, we have been able to push the boundaries of current science to realize a regime with adjusted pH levels and careful material selection to form a near ideal bond."

Perhaps one of the biggest advantages to our technology is the ability to allow power plants to move away from their typical locations on waterways.

"With our heat exchangers, you could have a power plant in a desert—thanks to the unique properties of supercritical fluids. How we plan to address future energy-water-climate dependency is a blind spot in today's energy policy. If we could eliminate water from the equation, it could potentially be considered a game-changing solution," says Bigham.

Bigham's research group also works on energy diversity. Currently beginning the second year of a three year grant of $920,000 from DOE, he is working with Samsung on next generation gas-driven technologies. "Natural gas is considered a bridge fuel—filling the gap from a fossil past to a renewable future. Under this DOE project, we focus to advance the state of the art in gas dryer technologies. We seek to dry clothes at higher energy efficiency and in a shorter cycle time," says Bigham.

Nearly 80 percent of large commercial facilities that rely on clothes dryers use gas-based fuels. These systems run almost continuously, so reducing energy consumption benefits profit and the environment.

"HVAC systems offer an efficiency greater than one. We are using a similar approach through thermodynamic cycles to leverage the behavior of water," he says.

Beyond the design, development, and testing of individual components, Bigham and his team have now focused their sights on combining the components and conducting system-level testing.

In the final year of the project, the team will conduct testing and send a prototype to Samsung and Oak Ridge National Laboratory for independent testing to verify and evaluate the technology under various conditions.

While introducing a new and promising technology, the team must also be committed to finding a cost-effective solution. "Introducing a viable energy solution is challenging because if they are not produced in a cost effective manner, they will remain at the lab level," says Bigham. "We rely on industry partnerships in these grants, so we can leverage their manufacturing expertise and they can guide our technology to ensure a viable option is brought to market."

Through the development of energy solutions that outperform existing methods, he enjoys his role in the lab helping students internalize key engineering concepts while the fruit of their labor benefits society.

"When students come into my lab, they bring what they've learned in the classroom to the next level. They get to work on diverse projects and create opportunities for themselves. I get to take them beyond basic science and it's been rewarding to see students excel," says Bigham.

WASTE NOT

Moving toward a sustainable future with ultimate use of all resources is the focus of research led by Dr. Ezra Bar-Ziv. To achieve that goal, Bar-Ziv has submitted a large proposal on waste valorization to the Department of Energy.

The proposal, focused on converting plastic wastes into composite materials using chemical recycling and reactive extrusion, involves 34 team members, nine North American institutions, seven companies, one non-profit organization, and two municipalities serving as the source providers.

"Our partnerships in this project have been critical to providing cost share to submit the proposal and also to be a proactive part of the project and the entire operation. We are further supported by a large and small municipality, both committed to a zero waste policy."

"Everything we are doing was carefully selected based on our holistic approach to turn plastic waste into composite materials," says Bar-Ziv.

One of the team members, Convergen Energy, is already working with Bar-Ziv to assemble the first plant to produce clean solid waste using industrial residues by December 2021, both at a more affordable price and with a low carbon footprint.

> *"An industrial-sized project converting a full facility is not something you expect to see in a university setting."*
> *—Dr. Ezra Bar-Ziv*

"We have a team of six PhD students dedicated to this project and when you pair that with our level of enthusiasm, we know we can accomplish great things," says Bar-Ziv.

The first step in the conversion process is the separation of plastics on conveyors at waste facilities. **Stas Zinchik** has put his focus on separating waste from a mixed waste stream.

"Using mid-range infrared technologies developed by NLIR with greater spectrometry bandwidths and speed, we are able to better identify the plastics we have on the conveyors," says Zinchik.

"Our goal is to deploy a sensor that can detect black plastics, polypropylene, and polyethylene-containing plastics and then record data using known source materials—training a machine learning algorithm to automate the characterization of incoming waste plastics, and understand what we are processing downstream."

Once the plastics are separated, the group will homogenize and produce pellets through a crumbling, downsizing, and cramming process so the materials can be easily conveyed.

"Following this step, we will take the plastic, melt it into a paste form that is moveable by mechanical means, and transport it into a reactor with a high temperature to produce pellets that are 97 percent pure and 99 percent uniform," says Bar-Ziv.

Realizing that the three percent impurity is not ideal, the team, which includes Dr. Armando McDonald from the University of Idaho, Dr. Karl Englund from Washington State University, **Drs. Joshua Pearce** and **Greg Odegard** from Michigan Tech, and others, will add silica or char reinforcements to the plastic or composite form to produce a reliable and useable feedstock for other manufacturing operations.

"We aren't just taking the pieces and melting them together. It is a chemical reaction that breaks down the plastics into carbon chains and re-polymerizes them into longer chain molecules, resulting in a new raw material which can be used as composites for decking and landscape timber, as well as in bathroom and kitchen products," says Bar-Ziv.

Another critical stage of the process is the deconstruction and reconstruction of the pellets.

Having already submitted their concept paper and being invited to submit a proposal, the group looks forward to the response from the Department of Energy in early fall.

If the proposal is selected, 20 percent of the proposed $13.5 million grant must be dedicated to education and outreach, helping further Bar-Ziv's vision to reduce waste.

"With help from **Drs. Craig Friedrich** and **Jacqueline Huntoon**, we are in the process of developing three new courses for a master's degree and a certificate in waste value creation, which we hope will serve as a model for other universities," he says.

> *"The proposed master's degree on waste value creation would help prepare professionals in a field of study where the US is currently lagging, and propel us toward a future where less waste ends up in landfills," says Bar-Ziv.*

INSTITUTIONS

- Michigan Tech
- University of Idaho
- Washington State University
- Western University
- Université Laval
- Universidad Autónoma de Tlaxcala
- Universidad Michoacana
- Instituto Politécnico Nacional
- Instituto Mexicano del Petróleo

COMPANIES

- Convergen Energy
- Kimberly Clark
- KOHLER
- AMCOR
- Forest Concepts
- re:3D
- Strandex

NON-PROFIT

- RTI International

MUNICIPALITIES

- Department of Public Works, Kent County
- Moscow County

READY FOR THE VOID

The road to Mars is paved with good polymers.

"Lighter. Stronger. Tougher. That's what we need in a material to support human deep space exploration," says **Dr. Greg Odegard**, PI for the Ultra-Strong Composites by Computational Design (US-COMP) institute.

He and a team of collaborators from 11 universities, two partner companies, and a national lab are working across four areas: computation, manufacturing, material synthesis, and testing. These development functions are being carried out in a coupled, parallel-path arrangement that leverages the nation's top research capabilities in each area.

The group is a compilation of faculty members from Florida State University, University of Utah, Massachusetts Institute of Technology, Florida A&M University, Johns Hopkins University, Georgia Institute of Technology, University of Minnesota, Pennsylvania State University, University of Colorado, Virginia Commonwealth University; as well as industry partners Nanocomp Technologies and Solvay with collaboration from the US Air Force Research Lab.

The diverse group is focused on developing a polymer from carbon nanotubes and resins that has triple the performance of the current state-of-the-art, while also focused on demonstrating a 50 percent increase in fracture toughness and meeting specific unit density and tensile strength objectives. It's a tall order, with long-term benefits to NASA and the country.

At the halfway point of the project, Odegard is looking forward to bringing his colleagues together within the group to focus on their advancements and chart the final stages of reaching the objectives.

"Up to this point, we have each been working in our small groups across the four areas, so now we are focused on eliminating some pathways to focus our resources as a full team," says Odegard.

"We have made progress toward tripling the performance of the current state-of-the-art, but we will need our remaining months to maximize every parameter and clear the bar."
—Dr. Greg Odegard

The group has been able to further identify key factors in making the composites stronger.

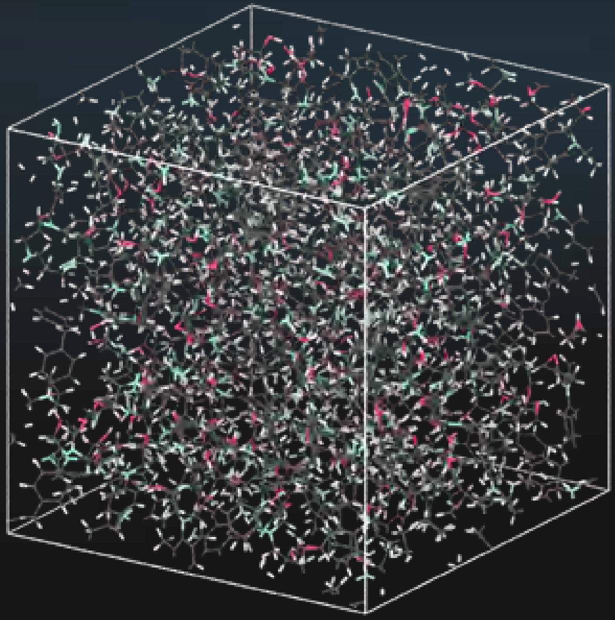
"We've learned things we didn't know when we started; we know what is holding us back, and now we are focused on attacking that problem as a group. It's the last major road block to getting something super special," says Odegard.

Beyond the research and development of a carbon nanotube material, the collaboration has been an important element for NASA.

Dr. Greg Odegard (left) demonstrating a prototype composite panel to NASA Administrator James Bridenstine (center) and Associate Administrator James Reuter (right) in December 2019.

"This is a new paradigm of research on a large scale–with larger funding, increased collaboration across multiple universities, and experts in modeling, materials, manufacturing, and testing," says Odegard.

"We would not be here if we were alone. Our success has come from working together with a broad group of researchers and industry experts."



HILLS BECOME MOUNTAINS

Few solutions emerge without supportive leadership from engineers. But what does a leader do when faced with a problem that is changing by the hour and facts are arriving by the minute, such as a wildfire, flood, or hurricane? Some problems are multi-faceted and decision makers need reliable supporting tools.

In 2019, a team of researchers at Michigan Tech, University of Michigan, Texas A&M, and the University of New Mexico received an Engineering Research Center (ERC) Planning Grant through the National Science Foundation (NSF) to develop tools for communities, first responders, and state and federal agencies to make informed decisions on resource allocation during emerging disasters.

If funded, the work would be completed under the Engineering Research Center for Emerging Disaster Engineering Encompassing Human Directed Expert Systems (ERC-DEES).

While the group does have plans to deploy autonomous agents to collect data via the air or the ground in these scenarios, their primary focus is not about engineering a hardware solution–it's about engineering solutions to societal problems.

"While there is extensive information available on disaster recovery and preparedness, our focus is on emerging disasters–rural or urban, manmade or natural. When infrastructure and communication are lost, we move into a complex and dynamic system with increased uncertainty around facts and information," says **Dr. Jeff Naber**, PI.

"We are developing the tools to close the gaps in information on what is needed to best protect people and get resources to those in need, particularly those without access to transportation or with more limited means."

For these dynamic situations, the team is proposing development of intelligent decision making tools that issue recommendations to a human agent through a dashboard, such as where first responders should focus their efforts.

"We are working to establish best practices for situational awareness, risk factors, and human reactions, which is why the system will ultimately make recommendations and a human will make the final call on who needs the most help," says Naber.

"In some cases, data will come from autonomous agents, but we will also be relying on social media, satellites, and cell phone data to make decisions—all while carefully assigning relative weight to the value and accuracy of the information—fostering informed decision-making."
—Dr. Jeff Naber

The system will collect the information across geographical locations of populations at risk: those that will soon be under water, in the path of a fire, or have a high priority for assistance due to lack of transportation.

"We don't need the center to develop autonomous agents—that's an engineering problem where large efforts have been applied. We need the center to focus on the human element—the privacy and trust issues. A level of trust has to be established between the information system and the human agents relying on it," says Naber.

"Even further, we have to look at the privacy issues when we bring in cell phone information, as far as what happens to the information, how it is stored, and what it is used for."

The center goes beyond engineering to the realms of policy, ethics, and culture. Decision making and data interpretation will play a critical role in achieving success.

"Utilizing standard machine learning, we will determine what we can and cannot believe and identify sources of disinformation in an extremely dynamic environment," says Naber.

> *"I work with engineers every day, but now I'm getting the perspectives of people—building an understanding from first responders, disaster preparedness plans, and learning how to take action in communities where trust is a challenge," says Naber.*

Ultimately, the system needs to be comprehensive and work across a wide range of scenarios. Whether housed within a government agency or a private company, the outputs could further impact policy and ethical guidelines for emerging disaster scenarios.

The ERC-DEES System aligns with strengths in the ME-EM Department in developing autonomy in unstructured environments, while bringing on leadership established in running University- and agency-based research centers.

Naber, with support from CO-PIs, **Dr. Greg Odegard**, Dr. Sheryl Sorby of the University of Cincinnati, Kellie Raffaelli (CDI), and Michael Bowler (Humanities), along with their partner institutions, will submit their preliminary proposal to the NSF following the close-out of their planning grant in October 2020, with the goal of being invited to submit a full proposal in January 2021.

Securing the grant is a milestone objective and would have a major impact on Michigan Tech. But the ultimate impact would be out there in society on a fateful day when responders are guided to stay one step ahead of disaster.

Having established their idea as valuable and feasible through the planning grant, the committee is leaving base camp to make their climb to the peak of the mountain.

ELEMENT 4

PIVOT & RESPOND

During the spring, summer, and fall semesters, the faculty, staff, and students at Michigan Tech showed true tenacity–adjusting to teaching and learning online and stepping up to conduct research and testing to battle the COVID-19 pandemic.

CULTURE OF KINDNESS

Last March, as universities across the nation moved their courses to remote instruction to help slow the spread of COVID-19, ME-EM Department Chair **Dr. Bill Predebon** had to act fast. Getting 1,736 students and 55 faculty members entirely online in just four days was no small task.

"We're a large mechanical engineering department, one of the largest in the nation, but because of our strong sense of community at Michigan Tech—our culture of kindness—there was an immediate sense of responsibility to respond in a coordinated way," he says.

Predebon turned to associate chair and director of undergraduate studies, **Dr. Jeff Allen**, who quickly became the Department's conduit for using online tools.

"He investigated the technology, so our faculty wouldn't have to," Predebon explains.

"The majority had never taught online before—only about a dozen of our faculty had taken Michigan Tech's online learning certification course," says Predebon.

Over the summer, the rest of the faculty completed the training. "I am proud of their efforts. We now have 100 percent certification for online learning," he says.

"The first thing I did was to rephrase the information," says Allen. "It had been presented by type of software, but not by function." Department faculty with online teaching experience also started helping—making phone calls and emailing their colleagues.

"It's difficult to give a lecture in an empty room. There's zero feedback," says Allen. "We were showing our faculty how to use the online lecture tools on campus. But then, within a day or two, as we realized what might be coming, I began urging faculty to gather all they would need to teach their courses from home."

Allen quickly bought webcams for faculty, along with headsets and microphones. "Everyone seemed to have a different kind of technology at home. Webcams sold out quickly. All around the country, everyone was doing the same thing," he said.

Allen's emphasis soon switched almost entirely to students.

Five years ago, the Department eliminated traditional mechanical engineering labs and replaced them with hands-on Mechanical Engineering Practice (MEP) courses. The MEP courses are designed to be adaptable so new subjects can be embedded as technologies advance. But how can these intensive hands-on courses be done virtually?

"Our Graduate Teaching Assistants really went above and beyond. Udit Sharma and JJ Song recorded a half semester's worth of video demonstrations in less than a week for the second MEP. There were similar efforts by faculty, staff, and graduate students for the other three MEP courses," said Allen. "They did an amazing job."

Meanwhile, another group was busy virtualizing the Department's Engineering Learning Center, an idea suggested by academic advisor, **Ryan Towles**. **Dr. Aneet Narendranath**, senior lecturer, spearheaded the effort.

"Our learning center supports our core courses—Thermodynamics, Statics, Dynamics, and Mechanics of Materials," says Predebon. "It was important for students taking these fundamental courses to access peer tutoring online, from home."

"Michigan Tech's Center for Teaching and Learning (CTL) shipped out document cameras to all our peer tutors," said Allen. "Then Narendranath coordinated a trial run—trying out the system as we put it into place. Several faculty volunteered as guinea pigs to let student tutors practice the system."

"Dealing with open-ended solutions, where there isn't one right answer, is a key part of the design of our MEP courses," says Predebon. "Those problem-solving skills helped our students adjust to learning from home."

"At home, just like our faculty, their technology and tools vary," adds Allen. "Some things really surprised us. For instance, very few students actually have a printer."

At one point, Predebon sent an email to all the students in his Department. He asked three questions: "What went right? What went wrong?" And then, "Are you having any issues with tools?" Almost immediately he received 80 responses from undergraduates. "It's important to solicit feedback directly from students while they are still in the midst of it," he says.

> *"The situation has shown the tenacity and caring demeanor of our faculty, staff, and students—our entire community. It was, and still is, a fantastic effort."*
> *—Dr. Bill Predebon*

SHIFTING FOCUS

As the pandemic unfolded, one Senior Design team, including **Haley Edie**, **Drew Scharlow**, **Andy Sleder**, **Theo Wachowski**, **John Winkler**, **Andrew Marogi** (Electrical Engineering), and **Ethan Twardy** (Computer & Electrical Engineering) pivoted from disappointment at a study abroad trip being cut short, to developing an electromechanical design for a device that automatically actuates a bag valve mask (BVM) to serve as a ventilator substitute.

Dr. Bill Endres, the team's advisor, reconfigured their 30-week senior capstone experience into a 12-week accelerated operation.

Use of a manual device to ventilate is frequently called "bagging" the patient. In medical emergencies, such as cardiac arrest, a BVM saves lives by force-feeding air into the lungs and are used by first responders and medical professionals.

"From the place the patient is discovered, to the ambulance and ER—we need something to seamlessly transition between them. Our device needs to be interfaced with other breathing circuits, including filters, pressure sensors, and pressure taps," Wachowski says of the device providing consistency for patients and medical professionals.

With a marketable product called CoVent, a small group consisting of **Austin Goudge** and Wachowski, under guidance from Endres, have extended their efforts over the summer through Michigan Tech's ICorps Site program, and are in the customer discovery process.

"We've met with 26 paramedics, EMTs, doctors, nurses, military—anybody in the field who can provide input," says Wachowski. "We're getting great responses and know this can help people. We are continuing to solicit feedback."

POWERED TOGETHER

Five years ago mechanical engineer **Apurva Baruah** was home in Mumbai, India, working in industry, when a former classmate first told him about Michigan Tech. Inspired, he applied, got accepted, and began his own journey as a Husky.

Upon arrival, he joined the crew of a J-30 sailboat, the Avantu Blu, owned by **Dr. Fernando Ponta**, and joined his research group optimizing rotor blades in wind turbines shortly after. "What a better way to understand the wind than trying to harness its power on sails," says Baruah.

Baruah also got involved in Graduate Student Government (GSG), advancing from graduate student liaison to ME-EM Department representative to elected president in 2018-19.

As GSG president, he worked to develop strong relations with units in the University's administration. During the pandemic, many graduate students, particularly international students, found themselves struggling. "COVID-19 has brought systemic shortcomings—funding, insurance, childcare, and housing—to the forefront," he adds.

> *"I appreciate all the work done by GSG and others to successfully raise funds to help. On behalf of all international students, I am immensely grateful to everyone who graciously donated to these initiatives."*
> *—Apurva Baruah*

In April, he completed his term as president and will defend his PhD later this year. After that, he'd like to pursue a post-doctoral research position or continue his work in wind turbine development, while exploring his other passion: aviation.

In a student-led effort, some Michigan Tech students have elected to donate the money they received from the Coronavirus Aid, Relief, and Economic Security (CARES) Act to help fellow students in need.

HUSKIES HELPING HUSKIES

In order to help alleviate the financial impact COVID-19 has had on students, Michigan Tech distributed $1.5 million from its CARES Act relief funds with a $350 grant to all eligible students. However, many students studying at American universities are not eligible to receive CARES Act funds, including international students.

In order to further assist students, Michigan Tech set up the Husky Emergency Assistance Fund. Yet as the pandemic has continued, the fund has diminished. "Students most impacted are not alone during this pandemic—GSG and their fellow students have their backs," said **Nathan Ford**, GSG president and a PhD student in mechanical engineering. Michigan Tech's GSG will match any portion of the $350 CARES Act funds that a student donates to the Husky Emergency Assistance Fund, up to $10,000.

MOBILE CLEANER

A refrigerated shipping container, commercial-grade baking sheets, a modified oven–key pieces of a heating system to clean personal protection equipment (PPE).

> **The idea is simple: expose PPE to high temperatures to deactivate coronaviruses in a moveable oven made with parts that are easy to purchase and assemble. Running continuously, the system can clean up to 5,000 PPE units every two hours—60,000 PPE units per day—and can clean hard-to-disinfect items like gurneys, beds, and firefighter turnout gear.**

An engineering team from Michigan Tech, alongside their industrial partner, Therma-Tron-X Inc., tested the prototype on campus with assistance from Aire Care, calling it the Mobile Thermal Utility Bioburden Reduction System (MTU-BRS).

The design uses an insulated shipping container with the refrigeration unit removed and replaced with a electric generator-powered heating unit. The system is lined with stainless steel trays holding PPE, heated to 167 degrees Fahrenheit, and held at temperature for 60 minutes.

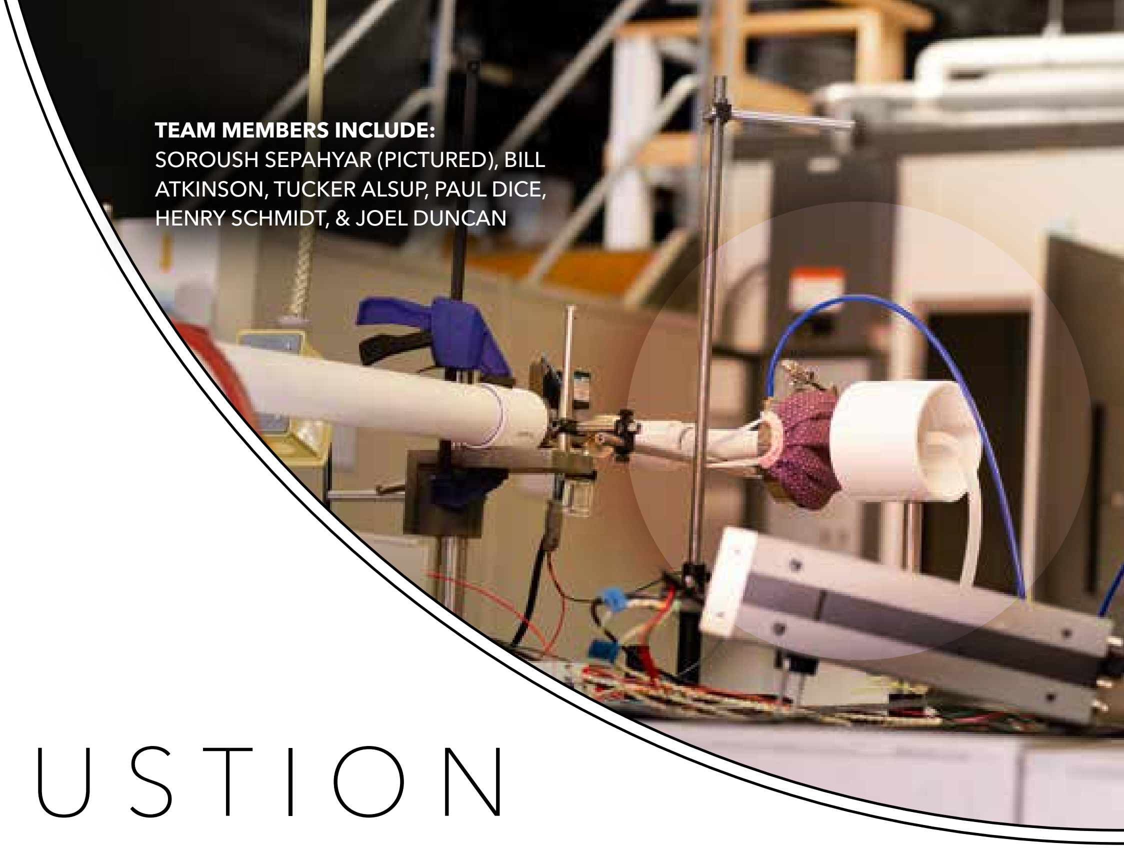
"Our goal is to make a scalable mobile sanitation unit for hospital PPE. We've seen DIY versions using food dehydrators and ovens; ours is bigger, but transportable," said **Dr. Andrew Barnard**, associate professor in the Department.

The team includes Dan Barnard, co-inventor of the design and his wife, Amy Barnard, a biomedical engineer. Barnard's father, Brad Andreae, Therma-Tron-X, Inc. owner, offered insight on the heating unit. Also instrumental to the project were thermodynamics experts, **Dr. Jeff Allen**, John F. and Joan M. Calder Professor in Mechanical Engineering – Engineering Mechanics, and Dr. Scott Wagner of Manufacturing and Mechanical Engineering Technology (MMET).

Vital to the build were Nick Hendrickson, Kevin Johnson, and Michael Goldsworthy, MMET; Chris Pinnow and Jamey Anderson, GLRC; with further support from Jessica Brassard, Mike Abbott, and Bill Korndenbrock.

With $32,800 from the College of Engineering, they are working with the Michigan Attorney General's office, InvestUP, Senator Ed McBroom, Representative Greg Markkanen, and Senator Adam Hollier. US representatives Fred Upton, Elissa Slotkin, and Jack Bergman and US Senator Gary Peters have championed the device in Washington, D.C.

The MTU-BRS was transported to Taylor Armory by the Michigan National Guard for deployment and is awaiting Food and Drug Administration Emergency Use Authorization.



TEAM MEMBERS INCLUDE:
SOROUSH SEPAHYAR (PICTURED), BILL ATKINSON, TUCKER ALSUP, PAUL DICE, HENRY SCHMIDT, & JOEL DUNCAN

FROM COMBUSTION TO COVID

Facing the global pandemic head-on, researchers at APS Labs on Michigan Tech's campus decided to repurpose their available technology and combine their analytical mindsets to make a difference by studying the effectiveness of the various materials used to make cloth face coverings.

"The idea started when we were talking about particle sizers used in the APS Labs facilities and seeing if those could be utilized to put real, hard numbers to the materials being used in masks so people have data to back up their purchases," says **Brian Eggart**.

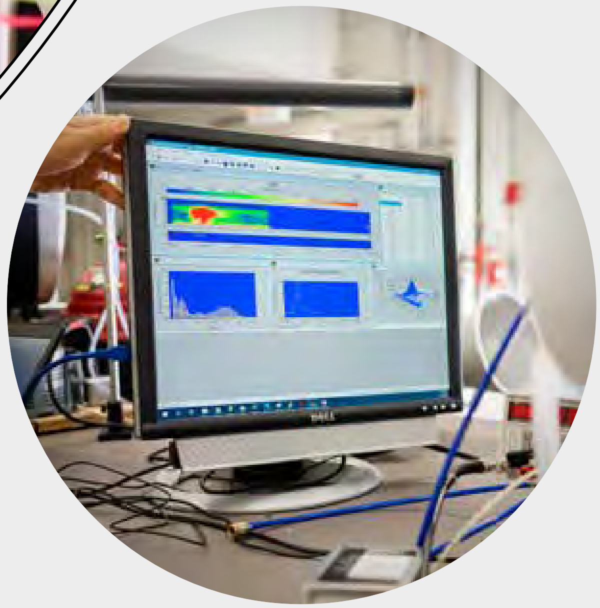
"Those side conversations turned into a discussion at a staff meeting and expanded when Dr. Jeff Naber brought up the concept of creating a machine that simulates a human cough to make the measurements more representative."

From there, the group took sketches on paper and found instrumentation and data acquisition tools in the labs to create a working concept.

> *"We investigated the profile of the human cough, focusing on the flow rate, pressure, and volume, and then started developing a machine to reproduce that. After several prototypes, we have settled on generating the aerosol using a nebulizer that is an approximation of respiratory droplets found in a human cough."*
> *—Brian Eggart*

The group has further adapted a device that counts and sizes the particles that transfer through the mask to help determine material effectiveness. This device is typically used for measuring soot generated by automotive engines, but is an excellent choice for this work as well.

"It is right in the ideal particle range, so it provides fast and precise data on size and quantity over time," he says.



While a majority of research models on mask material effectiveness show averages over one minute, the group's particle measurement technology allows them to quantify particle sizes at 10 cycles per second.

> *"Our instrumentation is very advanced; it's something we use routinely for engine research. Combined with our data acquisition systems, all the pieces are there and now we are pulling them together," says Eggart.*

"We want to establish repeatable tests through reliable and consistent instrumentation and experimental work that will ultimately lead to a benchmark report scientists can point to that documents mask material effectiveness. People have been looking for this information, so it's something we can share with consumers and provide quantifiable performance data."

As part of their process, the group hopes to provide further research on how mask effectiveness changes over time, studying the degradation process after repeated wash cycles.

Coming from the world of emissions research, where his work helps to make future snowmobiles cleaner and improve air quality further down the road, Eggart has been excited to work on a project that could have an immediate impact for the general population.

> *"We're not all going to change the world every day, but there are things we can do that aren't that expensive and will help protect ourselves, our families, and our communities. The results from this project will inform people on which materials will best protect them," says Eggart.*

TEAM EFFORT ACROSS CAMPUS

FEB. 2016

UNDETERRED PROGRESS

Michigan Tech returned to campus fully prepared to welcome students, faculty, and staff for face-to-face learning for the 2020-2021 academic year.

"There is significant opportunity to move ahead this year by being deliberate and moving toward our goals despite the pandemic. There are unknowns, but we will not let it halt our growth," says **Dean Janet Callahan**, College of Engineering.

Michigan Tech's proactive response is called MTU Flex, which allows for adjustments with less disruption to students, faculty, and staff to ensure continuity of education, teaching, research, and workflow—while continuing to prioritize the health of our community.

The flex plan ensures the University can respond to disruptions for the campus community, including financial changes, time to care for ill relatives or roommates, or lack of reliable internet.

MULTIFACETED TESTING PLAN

Michigan Tech began operating its COVID-19 testing lab in April. The lab can process approximately 150 individual samples per day, or 500 pooled samples per day, with 98 percent of results coming back in 36 hours.

The testing program included significant baseline testing from August 15-29, during the return of students to campus. It also includes ongoing testing to monitor the campus community during the fall semester.

Kelly Kamm, assistant professor of kinesiology and integrative physiology and an epidemiologist, and other Michigan Tech faculty and staff—including a medical doctor, a virologist, a chemical engineer specializing in vaccine development, plant and wildlife geneticists, microbiologists, and biomedical engineers—are leading the testing and monitoring programs across campus.

WASTEWATER WARNING SYSTEM

Wastewater monitoring on campus is a crucial component of the return-to-campus plan, as people shed the virus in feces before becoming symptomatic.

Studies have shown that SARS-CoV-2 levels in wastewater predict the number of symptomatic individuals infected with COVID-19. Weekly monitoring of wastewater flows on campus should reveal trends in the number of infections on campus, even in asymptomatic individuals.

Jennifer Becker, associate professor of civil and environmental engineering, said some of the sampling will occur at a location where the wastewater from several residence halls comes together into a single stream.

"We get a signal before people become symptomatic, which helps us determine where we need to direct resources to limit the spread," says Becker.

VACCINE RESEARCH

Dr. Caryn Heldt, James and Lorna Mack Endowed Chair in Bioengineering, leads the research on vaccines. In the short term, Heldt has the capability to purify viral vaccines quickly using chromatography, a process often used for protein purification.

Heldt, also director of Michigan Tech's Health Research Institute, and a team of researchers are building an understanding of the surface chemistry of the virus and how its interactions with surfaces—stainless steel, copper, plastic, cardboard—can increase its viability.

> *"Viruses have unique ways of interacting with surfaces. If water, like humidity, gets between the virus and surface, it can change the way the virus interacts with that surface."*
> *—Dr. Caryn Heldt*

ENGINEERING SOLUTIONS

HardwareX, edited by **Dr. Joshua Pearce**, has put out a call for papers to build an open-source, 3D printed ventilator and other COVID-19 medical hardware.

> *"Research on open-source ventilators is not new—a decade ago the technology was not there but now it is and we have substantial motivation."*
> *—Dr. Joshua Pearce*

Pearce, with joint appointments in the Department of Materials Science and Engineering and the Department of Electrical and Computer Engineering, runs the Michigan Tech Open Sustainability Technology (MOST) Lab and collaborates with Helpful Engineers, a group of makers, medical personnel, engineers, and researchers around the world. Here, many perspectives converge on a single goal: getting 3D printed, open-source ventilators and other medical hardware where they're needed.

SHIELDING PPE

More than 850 face shields designed for classroom instructors have been 3D printed in Michigan Tech's Van Pelt and Opie Library. Headset compatible, adjustable, and designed to direct exhalations behind instructors rather than toward students, the shields can be worn during lectures as part of the face covering requirement, effective inside all buildings and anytime six-foot physical distancing isn't possible outdoors.

The shields, based on an open-source design for local health care workers and first responders, have been modified based on faculty research. The primary modification comes from the shield's ability to redirect projected respiratory droplets, as well as features to enhance fit, accommodate headsets, reduce glare, and improve both flexibility and strength.

"This is still an evolving design as we move ahead," said **David Holden**, the library's manager of technology and innovation and one of the masterminds behind the 3D PPE project ongoing in the library since spring.

> *"There is no doubt the last several months have been challenging, not only for the University, but for each of us personally. In spite of this, the Michigan Tech community has risen to the occasion with empathy, compassion, and flexibility."*
> *—Michigan Tech President Rick Koubek*

THE STEADY RISE

The ME-EM Department has always striven to be recognized as having undergraduate and graduate programs among the best in the nation.

To support this vision, our faculty and staff have ceaselessly collaborated to strengthen our curriculum by infusing real-world, hands-on learning opportunities through laboratories and Senior Design projects, creating opportunities in Enterprises, and adjusting courses to align with industry trends.

As a result, our undergraduate program has sustained high enrollment and further experienced a steady rise since 2011.

The undergraduate program in our Department serves as the foundation for our mission so as we adjust curriculum content and bolster extra-curricular offerings, our faculty have ensured that each curriculum revision improves our level of quality.

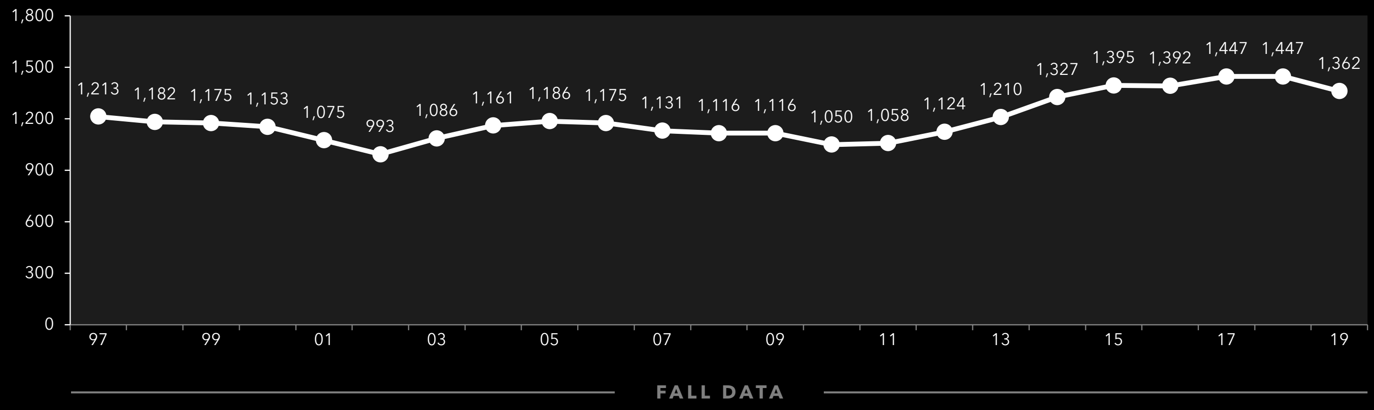
While our bachelor's degree enrollment has provided us with a strong reputation across the nation, we recognized that there was room for growth in the graduate program early on and made a conscious effort to expand enrollment.

This high reputation is reflected in our 95 percent career placement rating following graduation from our undergraduate program. Based on additional rankings from College Factual, we see our students rise to positions of growth within their companies by following their early- and mid-career earnings.

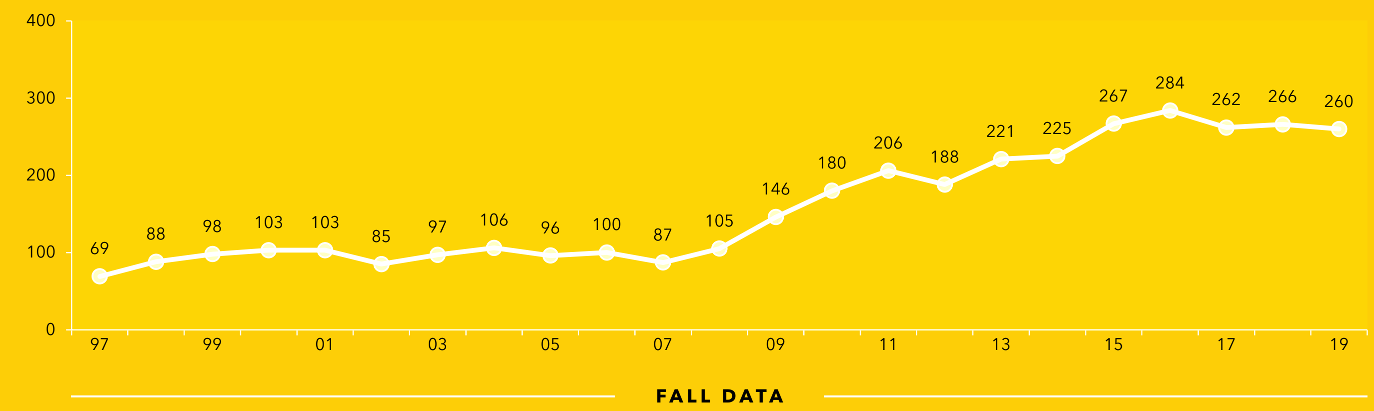
Our growth in the master's and PhD enrollment centered on a number of elements. We attribute much of our graduate program growth to our shift in focusing on centers and larger, collaborative research projects involving the Department, campus, and with other universities.

By securing larger grants, we have opened the doors to offer further support for our graduate students, increasing their involvement in research projects and providing additional hands-on, real-world learning opportunities that are the hallmark of our Department.

BS ENROLLMENT



MS ENROLLMENT



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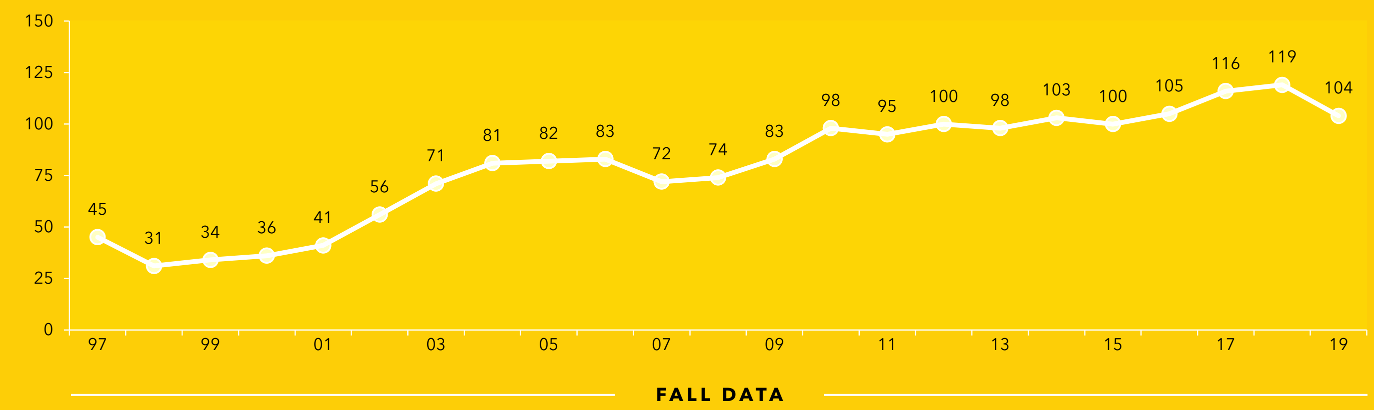


In a few cases, the BS enrollment and degree data may differ from past publications because the official, final enrollment data is only available after this publication goes to press.

21

THE ME-EM DEPARTMENT IS RANKED 21ST IN PHD DEGREES AWARDED BY THE AMERICAN SOCIETY FOR ENGINEERING EDUCATION

We further increased our enrollment by working with additional funding mechanisms for students who wanted to continue their education in the Department, relaxing outdated requirements that all master's students be funded by faculty or teaching.

We fostered a market with professionals who sought to self-fund a master's degree, while also creating opportunities for working engineers through distance learning programs at both the master's and PhD levels with minimal campus requirements and corporate partnerships.

The addition of distance learning programs has allowed us to become flexible and grow based on our students' needs.

It does require that we use best practices to manage remote graduate students and ensure that their degree is absolutely on par with on-campus students.

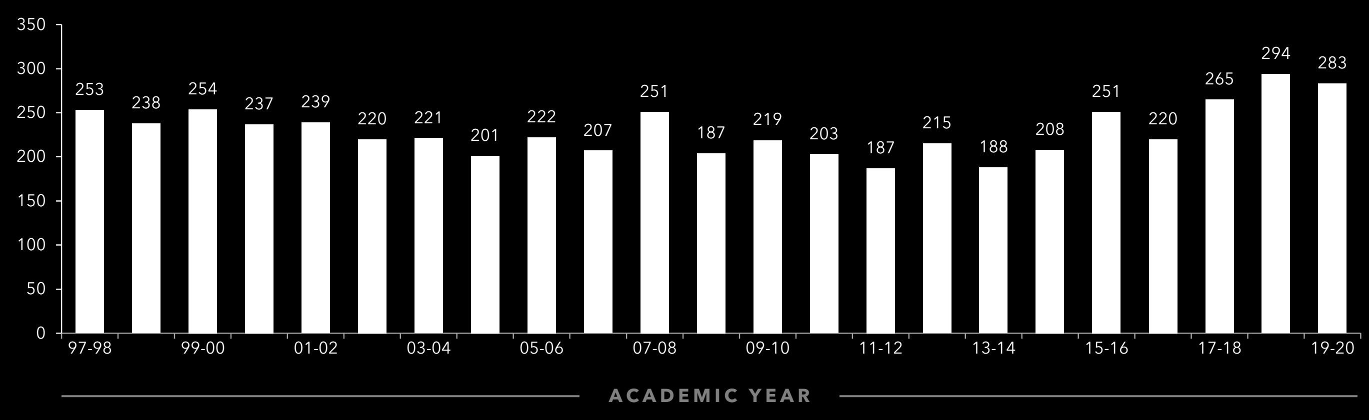
Generally this is achieved by utilizing laboratory and instrumentation resources at their place of employment with corporate support for the research.

Our shift in focus from bringing the students to campus for graduate school has created opportunities for us to share our campus with students across the country.

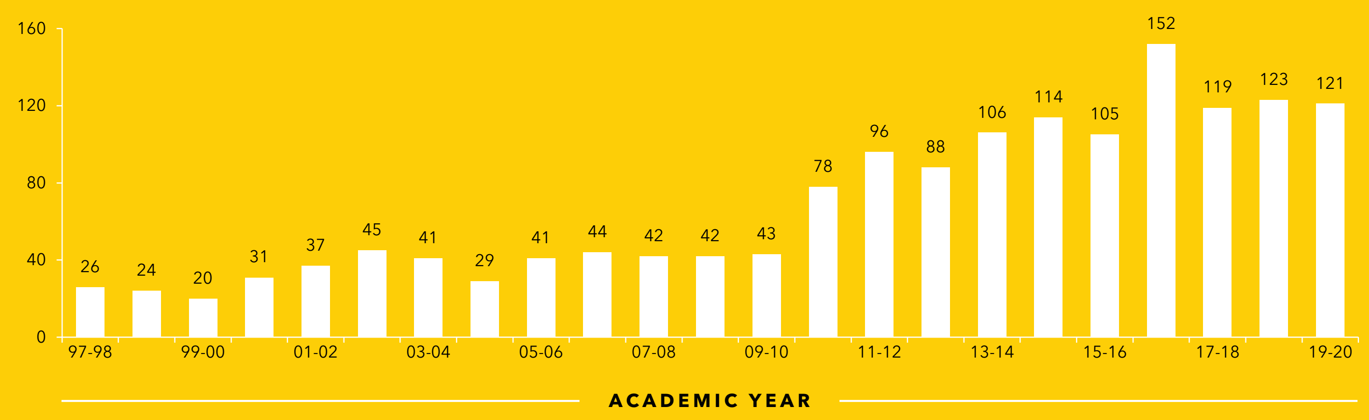
Further underpinning the growth of our Department are the faculty we have recruited and retained. We have emphasized bringing in diverse faculty with experiences directly from industry that can further bolster our students' educational experiences.

We are proud to have aligned our Department's objectives with our vision and continue to adjust our strategic plan to best support the growth of our enrollment, the increase of our educational quality, and the steady rise of our reputation.

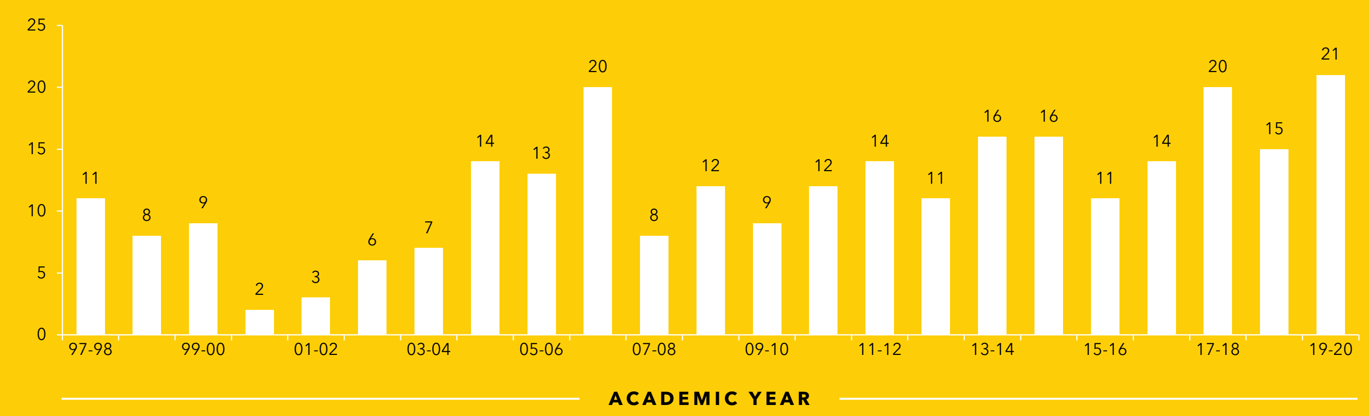
BS DEGREES



MS DEGREES



PHD DEGREES



ADAPTING TO ADVERSITY

Kyle Monroe, a native of Green Bay, earned several awards following his record-setting career playing basketball at Michigan Tech.

The 6-foot-5, 215-pound forward is an All-American, selected by the National Association of Basketball Coaches' (NABC) Division II. He set new career scoring records for Michigan Tech and the Great Lakes Intercollegiate Athletic Conference (GLIAC) and broke the single-game scoring record for Tech and the conference (53 points at Grand Valley State on January 23, 2020).

> Monroe surpassed Michigan Tech's all-time career scoring record set by Larry Grimes ('68-'72) at Lake Superior State on February 15, 2020. He was named the GLIAC Men's Basketball Player of the Year. Then, led by Monroe, the Huskies claimed the 2020 GLIAC Tournament Championship, the third in program history.

Monroe's career almost came to an end in the offseason after his junior year when he started getting debilitating headaches. Numerous doctors, and six MRI's, diagnosed Monroe with Chiari malformation, a serious condition requiring brain surgery. He was told he would never set foot on the court again.

The day before his scheduled surgery, a doctor at the Mayo Clinic, discovered he had been misdiagnosed. He had a spinal cord leak, but it could be injected with a patching material to seal his spine. Monroe underwent the procedure, and a month later was cleared to get back on the court. He hasn't had a headache since.

What's next? Do you want to keep playing basketball?
I am continuing my basketball career overseas this year.

Where have you been living during the pandemic? How do you fill the time?
During the pandemic I have been living at my family's home in Green Bay. I spend the majority of my free time either at the YMCA or The Driveway (a basketball training facility in Green Bay).

You and the team were ready to compete in the NCAA tournament last March when it was cancelled due to COVID-19. How did you come to terms with it?
My reaction at first was severe disappointment. After qualifying for the tournament in my final season, getting the news prior to our final flight was devastating. Once the entire country began to shut down, I realized many are facing much harder situations than missing a basketball tournament.

> *"I appreciate all Dr. Predebon has done for the mechanical engineering program and the support he has shown myself and my teammates."*
> *—Kyle Monroe*

STUDENT-ATHLETE.

ALUMNA.

COACH.

Michigan Tech mechanical engineering alumna, **Kristina Owen ('07)**, is the new head coach of Michigan Tech men's and women's cross country and track and field teams.

Owen was a three-sport student-athlete for the Huskies from 2003 to 2007, earning all-conference honors in cross country, track and field, and Nordic skiing. She was inducted into the Michigan Tech Sports Hall of Fame in October 2018.

> *"As a Tech alumna myself, I understand the unique demands our student-athletes face. I look forward to helping them reach their full potential for high-level collegiate performance, and then beyond as lifelong healthy athletes."*
> *—Kristina Owen '07*

Owen earned a bachelor's degree in mechanical engineering from Tech with a coaching endorsement certificate and volunteered as an assistant coach for the Huskies with the cross country and Nordic ski teams for two seasons, from 2009 to 2011. Since 2012, she has worked for Salomon, an equipment manufacturer that produces high-level skis and trail running shoes.

The native of East Wenatchee, Washington was a professional skier for three years (2007 to 2010) with CXC Elite and had four top 10 finishes at US Nationals.

BS GRADUATES (283)

SUMMER 2019 (16)

Ardell, Braeton
Coughlin, Jake
DeJong, Eric
Dion, Joseph
Frank, Jacob
Fusco, Dominic
Heyne Minehart, Cooper
Joseph, Benjamin
Justen, Nils - Summa Cum Laude
Kari, Jake
Lacko, Sam
McLeod, Mariah
Menard, Mitchell
Rettig, Anthony
Robinson, Jacob
Rose, Andrew - Summa Cum Laude

FALL 2019 (100)

Adams, Jacob
Aiken, Freddie
Babcock, Dillon - Summa Cum Laude
Balavich, Nicholas
Barrett, Helayna
Bell, Jason
Bench, Isac
Benson, Eric
Bieti, Matt
Blakeslee, Hunter
Boerman, Andrew
Bradford, Olivia
Breuer, Matthew - Magna Cum Laude
Buday, Nick
Curtis, Noah
Davenport, Landon
Davis, Alex
Doherty, James
Donovan, Daniel - Magna Cum Laude
Doran, Donovan - Magna Cum Laude
Drake, Stephen
Drogowski, Mike
Ellingson, Max - Cum Laude
Elliott, Edward
Evans, Austin
Evink, Nate
Eychaner, David - Cum Laude
Fedor, Tia - Cum Laude
Finch, Andy - Cum Laude
Flugaur, Troy - Summa Cum Laude
Getschman, Hannah
Gielda, Dan
Giesler, Ben - Magna Cum Laude
Giesler, Leslie - Summa Cum Laude
Grigsby, Chris
Guadagno, Marcello
Hamilton, John
Hansen, Mark
Hicks, Rachel - Cum Laude
Hoehnen, Mattias
Hogan, Ross - Summa Cum Laude
Huang, Weiming
Hvidhyld, Ashley
Ivers, Clare
Jensen, Nick - Magna Cum Laude
Jewell, Steph
Kastel, Austin
Kazadi, David
Krause, Austin
Kraydich, Calvin
Kubsik, Sara
Kurtz, Keenan - Cum Laude
Liburd, Stuart
Linder, Austin
Lipscomb, Eric
Lozano Jalomo, Alejandra
Maclean, John
Majors, Jake
Mangus, Nicholas
Marnach, Andy
Martin, Nick
McCole, David - Summa Cum Laude
Moeggenborg, Nick - Magna Cum Laude
Norkett, Riley
O'Brien, Morgan
O'Mara, Reese
Omberg, Will
Oparka, Kennedy
Patterson, George
Pawlak, Kody - Cum Laude
Peng, Jerry
Peters, Trenton
Pietsch, Brandon - Cum Laude
Quinde Serrano, Victoria
Raney, Gabriel
Salgat, Blake
Schweikart, Ben
Shawaryn, Tim - Cum Laude
Shively, Alex
Sieler, Alex
Spaulding, Jakob
Spence, Connor
Stagman, Brittany - Magna Cum Laude
Stanchina, Zach
Starzynski, Alex - Cum Laude
Stough, John - Magna Cum Laude
Tauchen, Dan
Tervo, Nate
Torola, Brian
Urban, Tyler
Van Linn, James
Walters, Thomas - Cum Laude
Warburton, Michael
Wentworth, Sean - Cum Laude
Wilkerson, Drew
Wilson, Nicole
Wolters, Ben
Xydis, Angela
Yanta, Nick - Magna Cum Laude
Zanon, Gnarls

SPRING 2020 (167)

Anderson, Nels
Anderson, Codi
Arenz, Austin - Magna Cum Laude
Arnold, Shane
Asplund, Erik
Baas, Brad - Magna Cum Laude
Ballou, Austin
Barbu, Noah - Magna Cum Laude
Barrett, Trevor - Magna Cum Laude
Bart, Jacob
Bauer, Eric - Magna Cum Laude
Becker, Sascha

Beggs, Bobby
Bessey, John
Bilkey, Jake
Blair, Ian
Blasius, Breanna
Bloom-Edmonds, John - Cum Laude
Bondi, Nathan
Brow, Kai
Bruck, Devon
Burdick, Jack
Butler, Cole
Carne, Erika
Carstens, Luke - Magna Cum Laude
Chintu, Nyasha
Cingel, Derek
Coral, Mitch
D'Alessandro, Gary
Daavettila, Lars
Dal Pra, Zach
Denooyer, Mitchell - Magna Cum Laude
Donajkowski, Hannah
Dorn, Allison - Cum Laude
Driesenga, James
Dunham, Josh
Eckert, Evan
Edie, Haley
Eide, Logan - Cum Laude
Elliott, Tim - Summa Cum Laude
Ericksen, Neal - Cum Laude
Evans, Jimmy
Fata, Spencer
Fedie, Jake
Fink, Kristine
Flancher, Nathan
Flaningam, Tyler
Frank, Sean
Franz, Jacob
Frybarger, Lucas - Cum Laude
Gaines, Leighton
Gradberg, Nathan
Guyon, Patrick
Hansley, William
Hardin, Cara
Hart, Noah - Magna Cum Laude
Haverdink, Heath - Cum Laude
Helbig, Haylie
Hoerter, Hunter
Houck, Eric - Magna Cum Laude
Howe, LeAnn - Magna Cum Laude
Hubbard, Ben - Summa Cum Laude
Hulbert, Brett - Magna Cum Laude
Impola, Brad
Ivers, Jack
Jacobson, Matthew
Jensen, Sabrina
Johnson, Josh
Johnson, Grant
Kase, Caleb - Cum Laude
Kehus, Emma - Magna Cum Laude
Keptner, Steven
Klynstra, Brendan
Korpics, James
Kotanchek, Kelvin
Krapek, Theron
Krsul, Jackson
Krusinski, Sam
Kruzel, Aaron - Cum Laude
Kyllonen, Ron
Lahnanen, Katie
Lakenen, Sam - Cum Laude
Lange, Jacob
Leaf, Bryce
Lehrer, Colleen
Lewis, Britten
Luke, Sean - Cum Laude
Mahonen, Ben
Maki, Ruth
Marion, Drew
Marker, Ethan - Summa Cum Laude
Mathias, Alex - Magna Cum Laude
McIntyre, Connor
McMichael, Riley - Cum Laude
Messina, Kenneth
Miller, Chance
Miller, Anthony
Miner, Camden
Moeggenborg, Adam
Montgomery, Ryan
Morrison, Ellen - Summa Cum Laude
Munro, Liam - Magna Cum Laude
Nelson, Samantha
O'Brien, Isabella - Cum Laude
Page, Thomas
Parvin, Brian
Pawloski, Sophie
Pedersen, Douglas
Peeters, Chris – Magna Cum Laude
Persson, Adam
Piekarek, Kami
Pietila, Jared
Pietila, Andy
Plahn, Nick
Pomranke, Luke - Cum Laude
Prigge, Seth - Magna Cum Laude
Radosa, Zachery - Summa Cum Laude
Ray, Al - Cum Laude
Reini, Will
Renke, Nick - Magna Cum Laude
Riemersma, Jarod - Magna Cum Laude
Rusinowski, Adam
Russell, Jarod
Salmi, Luke
Scharlow, Drew
Schatz, Garett - Summa Cum Laude
Schnabelrauch, Brett
Schneider, Cole - Summa Cum Laude
Schrader, Ryan - Cum Laude
Schrock, Somerset - Magna Cum Laude
Serra, Sophia
Simpson, Riley - Magna Cum Laude
Sitkins, Kyle
Sleder, Andy
Sluiter, Naomi
Smith, Garrett
Spillman, Philip
Squires, Noah - Summa Cum Laude
Stark, Noah - Magna Cum Laude
Sturos, Aaron
Swanson, Kassity
Swittel, Thomas
Tetzlaff, Nathan
Thibert, Derek
Thibodeau, Todd
Tiedt, Michael
Tolkkinen, Lance - Cum Laude
Tuma, Nic - Cum Laude
Uganski, Franklin - Magna Cum Laude
Undlin, Josh - Cum Laude
Utecht, Zach - Summa Cum Laude
Veldt, Nick - Cum Laude
Vivio, Anthony - Cum Laude
Wallach, Mark - Magna Cum Laude
Walsh, Joshua - Cum Laude
Ward, Trenton - Cum Laude
Wavrunek, Travis
Weaver, Michael
Weber, Alex
Werthman, Jason
Wiegand, Ben - Cum Laude
Winkler, John
Winter, Katie - Cum Laude
Wolff, Jacob - Magna Cum Laude
Wood, Ben - Cum Laude
Wu, Zongjing
Wyrzykowski, John

MS GRADUATES (121)

SUMMER 2019 (48)

Agarwal, Chetan Sanjay
Advisor: Sajjad Bigham
Multi-Scale, Capillary Assisted Copper Surfaces for Enhanced Pool Boiling Heat Transfer Processes

Anandan, Srivathsan
Advisor: Craig Friedrich
Course work only

Awathe, Arpit
Advisor: Craig Friedrich
Course work only

Balabadhruni, Manoj
Advisor: Susanta Ghosh
Strength Optimization of a High Symmetry Interlocking Micro-Architecture Polymer Composite

Basina, Laxmi Narayana Aditya
Advisor: Mahdi Shahbakhti
Modeling and Control of Maximum Pressure Rise Rate in RCCI Engines

Bhalerao, Pushkar Jayant
Advisor: Craig Friedrich
Course work only

Bhat, Pradeep Krishna
Advisor: Bo Chen
Study of Optimal Velocity Trajectory for Real-Time Predictive Control of a Multi-Mode PHEV

Deepak Jude Denny, FNU
Advisor: Craig Friedrich
Course work only

Desai, Vidyaprasad Rajendra
Advisor: Craig Friedrich
Course work only

Deshmukh, Anmol Sanjay
Advisor: Craig Friedrich
Course work only

Dinesh, Abhishek
Advisor: Craig Friedrich
Course work only

Dongare, Poonam Sahebrao
Advisor: Craig Friedrich
Course work only

Doshi, Nehal
Advisors: Mahdi Shahbakhti and Darrell Robinette
Modeling of Thermal Dynamics in Chevrolet Volt Gen II Hybrid Electric Vehicle for Integrated Powertrain and HVAC Optimal Operation Through Connectivity

Dusane, Aakash
Advisor: Craig Friedrich
Course work only

Gaganbir Singh, FNU
Advisor: Craig Friedrich
Course work only

Handa, Navrose
Advisor: Craig Friedrich
Course work only

Jacobson, Daniel J.
Advisor: Craig Friedrich
Course work only

Jacobson, Erica M.
Advisor: Jason Blough
Using Frequency Based Substructuring to Optimize Multi-Axis Resonant Plate Shock Tests

Jadhav, Akhilesh Arun
Advisor: Craig Friedrich
Course work only

Kapare, Nihal Pandit
Advisor: Craig Friedrich
Course work only

Katre, Dnyanesh Ajabrao
Advisor: Craig Friedrich
Course work only

Kolhar, Atharv Mahadeo
Advisor: Craig Friedrich
Course work only

Kulkarni, Mihir Gunesh
Advisor: Craig Friedrich
Course work only

Liu, Si
Advisor: Ye Sun
Theoretical Modeling and Power Optimization for the Contact-Separate Triboelectric Energy Generator

Lonikar, Kartikeya Vinayak
Advisor: Craig Friedrich
Course work only

Madala, Meghana
Advisor: Craig Friedrich
Course work only

Maharjan, Roman
Advisor: Mahdi Shahbakhti
Optimization of Diesel Engine and After-Treatment System for Series Hybrid Forklift Application

Mhatre, Shaunak Prasad
Advisor: Craig Friedrich
Course work only

Nagireddy, Sai Prudhvi
Advisor: Craig Friedrich
Course work only

Nigam, Siddhant
Advisor: Craig Friedrich
Course work only

Parepalli, Hareesh
Advisor: Craig Friedrich
Course work only

Parker, Zakarie R.
Advisor: Jeremy Worm
Effects of Variable Valve Actuation on Exhaust Enthalpy and Engine Out Emissions

Patankar, Sharvil Shailendra
Advisor: Craig Friedrich
Course work only

Pendyala, Venkata Satyanarayana
Advisor: Craig Friedrich
Course work only

Pise, Amey Ashok
Advisor: Craig Friedrich
Course work only

Sambhar, Ashna
Advisor: Craig Friedrich
Course work only

Sawant, Amey Arvind
Advisor: Chunpei Cai
Course work only

Sharma, Akshat
Advisor: Craig Friedrich
Course work only

16

THE ME-EM DEPARTMENT IS RANKED 16TH IN MSME DEGREES AWARDED
BY THE AMERICAN SOCIETY FOR ENGINEERING EDUCATION

Shinde, Aditya Dinesh
Advisor: Craig Friedrich
Course work only

Singh, Deelipkumar Manojkumar
Advisor: Craig Friedrich
Course work only

Slabaugh, Tristan J.
Advisor: William Predebon
Cathode Coupling in a Low Power Hall Thruster

Swartzmiller, Samantha G.
Advisor: Gordon Parker
Development of a Fused Deposition 3D Printed Buoy and Method for Quantifying Wave Tank Reflections

Trifaley, Aditya Samir
Advisor: Craig Friedrich
Course work only

Uras, Hakan H.
Advisor: Craig Friedrich
Course work only

Veeramaneni, Vinay Kumar Rao
Advisor: Craig Friedrich
Course work only

Vijayvergiya, Ayush
Advisor: Craig Friedrich
Course work only

Wang, Chun
Advisor: Scott Miers
Performance Improvement of a Single Cylinder, Air-Cooled, Spark-Ignited Engine Utilizing 1-D Cycle Simulation

Warty, Amarnath Ajit
Advisor: Craig Friedrich
Course work only

FALL 2019 (25)

Batool, Sadaf
Advisors: Mahdi Shahbakhti and Jeff Naber
Course work only

Bayani Ahangar, Shahab
Advisor: Chang Kyoung Chio
Course work only

Berndt, Conor T.
Advisors: Jeff Naber and John Johnson
An Experimental Study of a Passive NOx Adsorber (PNA) for the Reduction of Cold Start Diesel Emissions

Beroza, Alenna J.
Advisors: John Gershenson and Craig Friedrich
3D Printing in Low Resource Healthcare Settings: Analysis of Potential Implementations

Bhumkar, Omkar Sudhakar
Advisor: Greg Odegard
Crack Pattern Simulation of Pressurized Borosilicate Glass Tube Under Pellet Impact Using ALE Method

Chirakkal Kovilakom, Vishnu Prasad Varma
Advisor: Craig Friedrich
Course work only

Deshpande, Suyash Sanjay
Advisor: Craig Friedrich
Course work only

Inamdar, Juned Bashir
Advisor: Craig Friedrich
Course work only

Joshi, Ninad Milind
Advisor: Craig Friedrich
Course work only

Khandelwal, Raghav
Advisor: Craig Friedrich
Course work only

Koller, Micah R.
Advisor: Craig Friedrich
Design and Development of Personal Protective Equipment Products to Reduce the Impacts of Machete Injuries for Indigenous Ngabe Subsistence Farmers in Bocas Del Toro, Panama

Kotloski, Andrew J.
Advsiors: Mahdi Shahbakhti and Darrell Robinette
Course work only

Kulkarni, Saurabh Dattatrey
Advisor: Craig Friedrich
Course work only

Mandge, Devika Dilip
Advisor: Craig Friedrich
Course work only

Modi, Chaitanya
Advisor: Craig Friedrich
Course work only

Nair, Suraj
Advisor: Craig Friedrich
Course work only

Narendra Babu, Priyadharshan
Advisor: Craig Friedrich
Course work only

Patil, Chinmay Prakash
Advisor: Craig Friedrich
Course work only

Rajuvel, Saravanan
Advisor: Craig Friedrich
Course work only

Raste, Niranjan Uday
Advisor: Craig Friedrich
Course work only

Reno, Tyler M.
Advisor: Craig Friedrich
Course work only

Shinde, Shubham Dinesh
Advisor: Craig Friedrich
Course work only

Shiyekar, Omkar Mahesh
Advisor: Craig Friedrich
Course work only

Srivastava, Shivam
Advisor: Craig Friedrich
Course work only

Wesoloski, Colton J.
Advisor: Craig Friedrich
Course work only

MS GRADUATES (121)

SPRING 2020 (48)

Aarani Vijaya Kumar, Saravana
Advisor: Craig Friedrich
Course work only

Agarwal, Nikhilesh
Advisor: Craig Friedrich
Course work only

Allen, Aimee M.
Advisors: Jason Blough
and Andrew Barnard
Dynamic Testing: An Experimental Approach to Defect Identification in Additive Manufactured Parts

Atkinson, William R.
Advisor: Jeff Naber
Course work only

Bayaniahangar, Rasoul
Advisors: Joshua Pearce
and Craig Friedrich
3D Printing of Iron Oxide Incorporated Polydimethylsiloxane Soft Magnetic Actuator

Bhoge, Mahesh Madhukar
Advisor: Craig Friedrich
Course work only

Bollineni, Rahul
Advisor: Craig Friedrich
Course work only

Chadha, Lakshya
Advisor: Craig Friedrich
Course work only

Connolly, Ryan P.
Advisor: Craig Friedrich
Course work only

Deshmukh, Vikram Rajendra
Advisor: Craig Friedrich
Course work only

Dolan, Riley J.
Advisor: Craig Friedrich
Course work only

Guneja, Gaurav
Advisor: Craig Friedrich
Course work only

Harris, Nicholas C.
Advisor: Craig Friedrich
Course work only

Jain, Kanishk Sampat
Advisor: Craig Friedrich
Course work only

Joshi, Saurabh
Advisor: Craig Friedrich
Course work only

Kadam, Gaurav Ujjan
Advisor: Craig Friedrich
Course work only

Kafle, Hari Prasad
Advisor: Craig Friedrich
Course work only

Kamat, Vinayak Dattatraya
Advisor: Craig Friedrich
Course work only

Karne, Sukumar Subhash
Advisor: Craig Friedrich
Course work only

Kathiriya, Shreyash Maganbhai
Advisor: Craig Friedrich
Course work only

Kulkarni, Chinmay Aniruddha
Advisor: Kazuya Tajiri
Measurement of Current Distribution in the Land Channel Direction of a Proton Exchange Membrane Fuel Cell

Lakum, Suchith
Advisor: Greg Odegard
Course work only

Majhor, Casey D.
Advisor: Wayne Weaver
Optimal Mission Planning of Autonomous Mobile Agents for Applications in Microgrids, Sensor Networks, and Military Reconnaissance

McCole, David J.
Advisor: Craig Friedrich
Course work only

Meenakshisundaram, Satish Kumar
Advisor: Craig Friedrich
Course work only

Mehta, Dhruv Kalpesh
Advisor: Craig Friedrich
Course work only

Munegowda, Bannish Gowda
Advisor: Craig Friedrich
Course work only

Naidu, Yash
Advisor: Craig Friedrich
Course work only

Nalla, Sai Teja
Advisor: Craig Friedrich
Course work only

Netke, Akshay Vikram
Advisor: Craig Friedrich
Course work only

Parvatham, Ranadheer
Advisor: Craig Friedrich
Course work only

Patil, Abhishek
Advisor: Craig Friedrich
Course work only

Pinnu, Sunilkumar
Advisor: Sajjad Bigham
High-Performance Zero Liquid Discharge (ZLD) Treatment of High-Salinity Brines using a Multiple-Effect Absorption Distillation Concept

Prabhakara, Parijata
Advisor: Craig Friedrich
Increasing Access to PV Technology Through Sustainable Racking: A Review of Existing Literature and Ground Mounted Fixed Tilt Designs, and What Can Be Done Next

Punetha, Meenakshi
Advisor: Craig Friedrich
Course work only

Rathi, Sanskar
Advisor: Craig Friedrich
Course work only

Rehaman, Syed Anisur
Advisor: Craig Friedrich
Course work only

Sai, Pullela Shiva
Advisor: Craig Friedrich
Course work only

Santhosh, Pruthwiraj
Advisor: Darrell Robinette
Energy Consumption and Savings Analysis of a PHEV in Real World Driving Through Vehicle Connectivity Using Vehicle Platooning, Blended Mode Operation and Engine Start-Stop Optimizers

Shah, Vatsal
Advisor: Craig Friedrich
Course work only

Shahane, Rohit Dineshrao
Advisor: Craig Friedrich
Course work only

Shingala, Harsh Tushar
Advisor: Craig Friedrich
Course work only

Singh, Nitin
Advisor: Craig Friedrich
Course work only

Thill, Johanna R.
Advisor: Craig Friedrich
Generative Design in Energy Efficient Buildings

Vekaria, Shyam Bharatbhai
Advisor: Craig Friedrich
Course work only

Venkataramani, Ragunath
Advisor: Craig Friedrich
Course work only

Venkataramani, Ragunath
Advisor: Craig Friedrich
Course work only

PHD GRADUATES (21)

SUMMER 2019 (10)

Afkhami, Behdad
Advisor: Scott Miers
Development of a Turbulent Burning Velocity Model Based on Flame Stretch Concept for Spark Ignition Engines

Aramizo Ribeiro, Guilherme
Advisors: Mo Rastgaar and Ye Sun
Estimation and Prediction of the Human Gait Dynamics for the Control of Ankle-Foot Prosthesis

Chundru, Venkata R.
Advisors: Gordon Parker and John Johnson
Development of a 2D SCR Catalyst on a Diesel Particulate Filter Model for Design and Control Applications to a Ultra Low NOX Aftertreatment System

He, Xin
Advisor: Chunpei Cai
Slip Boundary Layer Flow Stability Analysis and Micro-Plasma Jet End Flow Modelling

Jane, Robert S.
Advisors: Gordon Parker and Steven Goldsmith
Networked Microgrid Optimization and Energy Management

Knop, Lauren N.
Advisors: Mo Rastgaar and Ye Sun
Estimation of Multi-Directional Ankle Impedance as a Function of Lower Extremity Muscle Activation

Penhale, Miles B.
Advisor: Andrew Barnard
Acoustic Localization Techniques for Application in Near-Shore Arctic Environments

Schroeter, Robert A.
Advisor: Jeff Naber
Characterization of the Post Injection Behavior of Gasoline Direct Injection Fuel Injectors

Zhang, Kai
Advisor: Chunpei Cai
On Dilute Plume and Impingement Flows in Space Engineering

Zinchik, Stas
Advisors: Ezra Bar-Ziv and Jordan Klinger
Paddle Mixer-Extrusion Reactor for Torrefaction and Pyrolysis

FALL 2019 (7)

Desouky, Mohammed Abdelrahman Abdelaziz
Advisor: Ossama Abdelkhalik
Algorithms and Optimal Control for Spacecraft Magnetic Attitude Maneuvers

Huang, Hui
Advisors: Ye Sun and Shiyan Hu
Cloud Manufacturing Based Embroidered Wearable Electronics for Daily ECG Monitoring

Lyu, Jianyang
Advisors: Ossama Abdelkhalik and Fernando Ponta
Optimization and Control of Arrays of Wave Energy Converters

Pisani, William A.
Advisor: Greg Odegard
Molecular Dynamics Modeling of PEEK, Cyanate Esters, and Carbon Nanotubes for Aerospace Applications

Riegner, Kayla L.
Advisors: Kelly Steelman and Craig Friedrich
Ground Vehicle Driving Aids: Assessing Driver Workload and Performance in Degraded Visual Environments

Yang, Zhuyong
Advisor: Jeff Naber
Optimization and Comparison of Over-Expanded and Other High Efficiency Four-Stroke Spark-Ignited Boosted Engines

Zhu, Xiucheng
Advisor: Seong-Young Lee
High Injection Pressure DME Ignition and Combustion Processes: Experiment and Simulation

SPRING 2019 (4)

Al Mahmud, Hashim Naji Azooz
Advisor: Greg Odegard
Multiscale Modeling of Carbon Fibers/Graphene Nanoplatelets/Epoxy Hybrid Composites for Aerospace Applications

Dudekula, Ahammad Basha
Advisor: Jeff Naber
Sensor Fusion and Non-Linear MPC Controller Development Studies for Intelligent Autonomous Vehicular Systems

Miganakallu Narasimhamurthy, Niranjan
Advisor: Jeff Naber
Water Injection and its Impact on Knock Mitigation in Spark Ignited Engines

Song, Jiajun
Advisor: Ossama Abdelkhalik and Jeff Allen
Optimization of Shape and Control of Linear and Nonlinear Wave Energy Converters

65

GRADUATE SCHOOL RANKED 65TH (TOP 38%) AMONG ALL US DOCTORAL-GRANTING ME DEPARTMENTS BY US NEWS & WORLD REPORT

ORDER OF THE ENGINEER

FALL 2019
Lawrence W. Staley '86
Entrepreneur – CEO at Staley Ventures

SPRING 2020
Virtual event

GRADUATE STUDENT FELLOWSHIPS

SUMMER 2019-SPRING 2020

Doctoral Finishing Fellowships
Saeed Jafari Kang
Abdelrahman Abdelaziz
Xin Wang
Behdad Afkhami
Kai Zhang
Sarah Jalal
Mingyang Li

Outstanding Graduate Student Teaching Award
Sambhaji Bamane
Salman Husain
Divya Kamlesh Pandya
Suraj Prabhu
Soroush Sepahyar
Udit Sharma
Cora Taylor
Mitchell Timm
Stephania Vaglica
Jiachen Zhai
Menghan Zhao

Dean's Award for Outstanding Scholarship
Shahab Bayani Ahangar
Suyash Sanjay Deshpande
Abdelrahman Desouky
Mingyang Li
Joseph Oncken
William Pisani
Xin Wang
Zhuyong Yang

Graduate Student Service Award
Jon Furlich

2019-2020

NEW FACULTY

DR. JUNG YUN BAE

Dr. Jung Yun Bae joined the Department this fall as an assistant professor. She received her BS and MS from Hongik University in Seoul, Korea in 2005 and 2007 respectively, and her PhD in Mechanical Engineering from Texas A&M University in 2014.

Upon receiving her PhD, Bae served as a research professor in the Intelligent Systems and Robotics Laboratory at Korea University in Seoul, Korea from 2014 to 2015 and from 2018 to 2019. Her research strengths lie in robotics and optimization.

DR. SUSANTA GHOSH

Dr. Susanta Ghosh continues his career with the Department as an assistant professor. He received his BSE in Civil Engineering from the Indian Institute of Science and Technology, and both his MSc in Engineering in 2003 and his PhD in Civil Engineering from the Indian Institute of Science, Bangalore in 2008.

He did postdoctoral work with Duke University, the University of Michigan, and the Technical University of Catalunya, Barcelona; before serving as a research assistant professor with the Department from 2015 to 2019.

His areas of research include computational science and atomistic-continuum material modeling utilizing data-driven analysis and machine learning.

DR. SRIRAM MALLADI

Dr. Sriram Malladi joined the Department as an assistant professor. He received his BTech in Mining Machinery Engineering from IIT Dhanbad, India in 2011, and both his MS and PhD in Mechanical Engineering from Virginia Tech in 2013 and 2016 respectively.

Malladi came to us from Virginia Tech's Vibrations, Adaptive Structures, and Testing (VAST) Lab where he worked as a research scientist from 2016 to 2019.

His research interests include structural dynamics, adaptive systems, and instrumented structures utilizing data-driven analysis and machine learning.

DR. MYOUNGKUK PARK

Dr. Myoungkuk Park joined the Department as a research assistant professor. He received his BS in Mechanical Engineering from Kyungkhee University in Seoul, Korea in 2002, his MS in Mechanical Engineering from Korea University in 2004, and his PhD in Mechanical Engineering from Texas A&M University in 2014.

Before joining the Department, Park worked in industry as a senior, then principal engineer for several years at Samsung Electronics in Asan, Korea.

His areas of expertise include smart factory and manufacturing automation and mobile robots.

DR. PAUL VAN SUSANTE

Dr. Paul van Susante continues his career in the Department as an assistant professor. He received a BS and MS in Civil Engineering from TU-Delft, in the Netherlands in 2001, and his MS and PhD in Engineering Systems from the Colorado School of Mines in 2004 and 2011 respectively.

Upon receiving his PhD, van Susante served as an adjunct instructor with the Colorado School of Mines, Division of Engineering; then taught in the Department as a lecturer from 2012 to 2015 and as a senior lecturer from 2015 to 2019.

His areas of research include in-situ resource utilization and soil machine interaction in deep space.

DR. YONGCHAO YANG

Dr. Yongchao Yang joins the Department as an assistant professor. He received his BE in Structural Engineering from Harbin Institute of Technology in China in 2010 and his PhD in Structural Engineering from Rice University in 2014. He worked as a technical staff member at Argonne National Laboratory from 2018 to 2019 and a director's postdoctoral fellow at Los Alamos National Laboratory from 2015 to 2017. His research focuses on structural dynamics, computer vision, and physics-informed deep learning.

2020-2021 NEW FACULTY

DR. ANA DYRESON

Dr. Ana Dyreson joins the Department as an assistant professor. She received her BS in Engineering Mechanics, an MS in Mechanical Engineering from Northern Arizona University, and her PhD in Mechanical Engineering from the University of Wisconsin – Madison. Dyreson did her post-doctoral research at the National Renewable Energy Laboratory. Her research expertise includes renewable energy and energy-water-climate nexus.

DR. KARTIK IYER

Dr. Kartik Iyer joins the Department with a one-third split appointment as an assistant professor, and two-thirds in the Physics Department. He received his MS and PhD from Georgia Tech, and completed postdoctoral studies at the University of Rome and New York University. His research interests broadly encompass fluid mechanics, heat transfer, numerical algorithms, and high performance computing.

DR. FEI LONG

Dr. Fei Long joins the Department as a lecturer. He received his PhD from Shanghai Jiaotong University in China in 2011. He then served as an application scientist for two years in the Nano Surfaces Division, Bruker Co., which manufactures scientific instruments. Long has been with the ME-EM department since 2013, first as a post-doctoral research associate for one year, and then as an instructor. His areas of research expertise include nanomaterials and scanning probe microscopy (SPM).

DR. MARY ZADEH

Dr. Mary Zadeh joins the Department as a lecturer. She received a BSME from the University of Guilan, an MSME from the Power and Water University of Technology, and an MSME and PhD from Michigan Tech. She was a lecturer at Damavand Azad University in Tehran for a year. While working on her PhD the past three years, she served as a GTA and GRA in the Department. Her research interests include internal combustion engines, optical and laser diagnostics, hybrid electric vehicles, and automotive systems.

NEW STAFF

GRANT OVIST

Grant Ovist joined the Department's Advanced Power Systems Research Center (APSRC) as operations manager in education and training. He received his BS and MS in Mechanical Engineering from Michigan Tech in 2007 and 2016 respectively. He brings 12 years of experience from GM in engine controls, calibration, emissions testing and certification, government relations, systems engineering, component design, and global corporate training. He will be managing APSRC's training programs, including Mobile Lab.

JAMIE SCHULTZ

Jamie Schultz joined the Department office staff in September as an Administrative Aide. She transferred in from Michigan Tech Chem Stores and has held several other positions outside of the University. She brings with her a dedicated and customer-focused approach and we are delighted to welcome her to the team.

PROMOTIONS

Paul Dice - Research Engineer II in the ME-EM APS Labs

Brian Eggart - Research Associate in the ME-EM APS Labs

Marlene Lappeus - Director of Business Operations for the Advanced Power Systems Research Center (APSRC)

Bob Page - Director of Laboratory Facilities in the ME-EM Department

Henry Schmidt - Research Engineer II in the ME-EM APS Labs

Marty Toth - Research Engineer/Scientist in the ME-EM APS Labs

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UNDERGRADUATE SCHOOL RANKED 34TH (TOP 10%) AMONG ALL US DOCTORAL-GRANTING ME DEPARTMENTS BY US NEWS & WORLD REPORT

AWARDS

Dr. Jung Yun Bae, assistant professor, was selected as a recipient of a 2019 Research Seed (RS) grant. The goal of her research is the development of operational strategy for multi-agent autonomous vehicle systems. Her research interests include coordination of heterogeneous robot teams, vehicle routing problems, multi-robot system control and optimization, autonomous navigation, and unmanned vehicles.

Dr. Andrew Barnard, associate professor, was presented with the Michigan Tech 2019 Distinguished Teaching Award in the Assistant Professor/Lecturer/Professor of Practice Category. Selection for the award, which recognizes outstanding contributions to the instructional mission of the University, is based on student ratings of instruction responses and input from students, staff, faculty, and alumni.

Dr. Nancy Barr, professor of practice, has been elevated to IEEE Senior Member status. In addition to developing an extensive communication and teaming undergraduate curriculum in the ME-EM, Barr teaches two graduate communication courses. She is secretary to the IEEE Professional Communication Society Board of Governors and the ASEE North Midwest Section Campus Representative.

Dr. Barr was elected to the IEEE Professional Communication Society's (PCS) board of governors. The PCS's mission is to foster a community dedicated to understanding and promoting effective communication in engineering, scientific, and other technical environments. Her three-year term began January 1 and runs through December 31, 2022.

Dr. Bo Chen, professor, has received the designation of Fellow from the American Society of Mechanical Engineers (ASME). The ASME Committee of Past Presidents confers the Fellow grade of membership on worthy candidates to recognize their outstanding engineering achievements.

Dr. Jaclyn Johnson, senior lecturer, was recognized by her students and colleagues during an IDEA Hub/Center for Teaching and Learning Q&A Session and Workshop in June. She was one six instructors to be recognized as having done an excellent job of managing the sudden transition to online teaching in the wake of COVID-19.

Dr. John Johnson, research professor and professor emeritus, has been named by SAE International to the inaugural Contributor of the Year Class, recognizing those for their ongoing commitment and contributions to the organization and the entire mobility industry.

Dr. Jeff Naber, Richard & Elizabeth Henes Endowed Professor in Energy Systems and director of the APS Labs, has been appointed as an associate member of the Department of Energy's (DOE) USDRIVE Committee.

Dr. Naber was also appointed to the Executive Committee of the Automotive Research Center (ARC) by the center's director, Bogdan Epureanu.

Dr. Aneet Narendranath, senior lecturer, was honored as the runner-up for the ME-EM Teacher of the Year Award at the 2020 virtual Order of the Engineer Induction Ceremony held in May.

Dr. Gordon Parker, John & Cathi Drake Endowed Chair in Mechanical Engineering, was honored at the ME-EM Order of the Engineer Ceremony with the 2020 ME-EM Teacher of the Year Award as selected by the undergraduate students in the Department. One student said of Parker, "He not only encourages the success and growth for each student in his class, but also provides the tools for everyone to do so. Not many students want to miss his lectures, as they are interesting, engaging, and fun. He spends a great deal of his free time creating quality notes and examples that are easy to follow and help a lot to understand the material."

Dr. William (Bill) Predebon, J. S. Endowed Department Chair and Professor, traveled to Washington to be inducted into the Pan American Academy of Engineering. The Academy honors the exceptional engineers, who, prestige of their profession, have contributed decisively to the progress of their country and continent.

Dr. Predebon was also presented with a certificate of recognition for his commitment to engineering education and continuous service to the society at the ASME International ME Education Leadership Summit in New Orleans. Predebon has been involved with the ASME Committee on Engineering Education for the past 20 years, has served as VP and Chair, and continues to work closely with the committee to further mechanical engineering education at all levels.

Dr. Darrell Robinette, assistant professor, was honored by SAE International with a 2020 SAE Ralph R. Teetor Teaching Award in recognition of his outstanding contributions that distinguish him as one of the top engineering educators. The award stimulates contacts between younger engineering educators and practicing engineers in industry and government.

Dr. Sheryl Sorby, research professor and professor emerita, was elected president of the American Society for Engineering Education (ASEE). Sorby received her MSME and PhD from the ME-EM Department at Michigan Tech. She retired in 2011 from Michigan Tech as professor in the ME-EM Department and is currently a professor of engineering education at the University of Cincinnati.

Dr. Ye "Sarah" Sun was promoted from assistant professor without tenure to associate professor with tenure as approved by Michigan Tech's Board of Trustees at their May 20, 2020 meeting.

Dr. Jeremy Worm, associate director of APS Labs and director of the Mobile Lab at Michigan Tech, was appointed by Governor Gretchen Whitmer to the Michigan Truck Safety Commission.

MISSION

PREPARE ENGINEERING STUDENTS FOR SUCCESSFUL CAREERS.

VISION

BE A NATIONALLY RECOGNIZED MECHANICAL ENGINEERING DEPARTMENT THAT ATTRACTS, REWARDS, AND RETAINS OUTSTANDING STUDENTS, FACULTY, AND STAFF—BE A DEPARTMENT OF CHOICE NATIONALLY.

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Manufacturing & Industrial Area Director

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PAULA F. ZENNER, MS
Director of Operations & Finance

DR. GREGORY M. ODEGARD
Director of Research

DR. WILLIAM W. PREDEBON
J.S. Endowed Department Chair & Professor

DISTINGUISHED TEACHER

During the start of the pandemic last spring—amid lockdowns and virtual courses—maintaining the connection between student and professor became especially important.

Dr. Saeedeh Ziaeefard ('18) was recently recognized for her exemplary ability to do just that when she earned the ECE Distinguished Teaching Award at The Ohio State University.

Ziaeefard, a Michigan Tech alumna, is a faculty member in the Department of Electrical and Computer Engineering at Ohio State. She earned her PhD in Mechanical Engineering from Michigan Tech in 2018.

> *I see my students first as humans, then as students. I try to be caring in everyday interaction and be patient with them."*
> *—Dr. Saeedeh Ziaeefard '18*

At Ohio State, Ziaeefard teaches several courses, including Introduction to Feedback Control, Introduction to Real Time Robotics, Technical Writing and Presentation, and Circuit Analysis.

Her research interests include engineering education, control, and navigation of autonomous underwater vehicles.

When Ziaeefard thinks about teaching, she reflects back on her time as a student.

> *"I had excellent mentors, which makes me want to be the same for my students," says Ziaeefard.*

"I had a great professor who taught me how to connect the theories and fundamentals with real life applications. I learned to ask 'why' and find solutions. It's rewarding when you see that 'aha' moment on your student's face, regardless of how long it takes," she says.

At Michigan Tech, Ziaeefard earned the University's Outstanding Graduate Student Teaching Award as a student and research assistant in the Nonlinear and Autonomous Systems Lab (NAS Lab), where she helped develop a low cost, highly maneuverable underwater glider, ROUGHIE (short for Research Oriented Underwater Gliders for Hands-on Investigative Engineering).

Ziaeefard developed and implemented control strategies to increase the performance and maneuverability of ROUGHIE. She also shared her passion for underwater robotics with middle and high school students in her spare time.

> *"I try every day to find a balance and be more inclusive in my classroom. It's a challenging but possible task," says Ziaeefard.*

HALLQUIST GIVES BACK

John O. Hallquist, an alumnus with a long and generous history of philanthropy, has made a major donation to the Department. His $2 million gift will create the John O. Hallquist Endowed Chair in Computational Mechanics.

Earning his master's and PhD in engineering mechanics at Tech in 1972 and 1974, respectively, John Hallquist is the developer of the LS-DYNA® software suite, the most highly used, advanced general-purpose multi-physics simulation software package worldwide. He is also the inventor or co-inventor on 19 industry patents.

Computational mechanics is interdisciplinary. Its three pillars are mechanics, mathematics, and computer science, Predebon explains. "We're already strong in this area. With this endowment we will be able to expand our leadership position on national and international levels."

Hallquist is confident the University will make the most of the opportunities presented through the position. "The time I spent in the ME-EM Department at Michigan Tech provided an invaluable asset for my future: a 45-year career in simulation software development. I remain very grateful to the department for their confidence in me by providing full financial support during my time on campus. I hope that the creation of this endowed chair will help Tech attract even more talented scientists in computational mechanics," Hallquist says.

After graduation, Hallquist began his engineering career at the Lawrence Livermore National Laboratory (LLNL). There he interfaced with the physics department and started running their codes.

"I contributed to these codes, which were released into public domain and distributed across the United States, Europe, and Asia," Hallquist says.

In 1987, Hallquist founded Livermore Software Technology Corporation (LSTC) to develop a commercial version of the public domain codes covering their combined capabilities and expanding their applications.

"My son, Nathan, was critical to our success from an early age, working on both the software and hardware after school. Members of my family have always been supportive," adds Hallquist.

LS-DYNA® is used worldwide in the automotive industry to analyze vehicle designs and evaluate prototypes, while providing accurate predictions on the effects of vehicle crashes on occupants. The analysis tools are used for applications in automotive, aerospace, manufacturing, metals, electronics, construction, defense, and consumer products.

Inducted into the Department's Mechanical Engineering and Engineering Mechanics Academy in 2001, Hallquist has been recognized nationally as a member of the US National Academy of Engineering. In 2012, Hallquist was inducted into the Lawrence Livermore National Lab Entrepreneurs Hall of Fame.

> *"We're forever grateful for John's generous contributions to the field and the Department."*
> *—Dr. Bill Predebon, ME-EM Department Chair*


TECH
HUSKY A200

EXTERNAL ADVISORY BOARD

The External Advisory Board (EAB) is a select group of corporate, university, and government leaders, many of whom are alumni. EAB members share their expertise and provide assistance with curriculum direction, research topics, resource development, and education-industry partnership.

They offer professional insight and provide valuable input, shaping the state-of-the art engineering education that takes place in the ME-EM Department. Members can serve a maximum of two four-year terms.

Kirby Baumgard, John Deere Power Systems (term ending Fall 2020)

John Bogema, Ford Motor Company

Brett Chouinard, Altair Engineering, Inc.

Marie Cleveland, FedEx (Retired)

Justin Dahlager, John Deere (new member Spring 2020)

Michael Davenport, US Steel

Brian Demos, AAM - American Axle & Mfg.

Christopher Duke, FCA - Fiat Chrysler Automobiles

Alexa Ellswood, General Motors Company

Kimberly Foster, Tulane University (new member Spring 2020)

Alan Frank, Whirlpool Corp.

James Heldt, Mercury Marine

Colleen Jones-Cervantes, Chevron Corp.

Shashi P. Karna, US Army Research Lab

Frank Leban, US Navy

Leah Lemanski, Nexteer Automotive Corp.

David Lomasney, Maclean Fogg Component Solutions (new member Spring 2020)

Jeffery Lynch, Dow Performance Silicones (term ending Fall 2020)

Jason Maes, Stryker Corp. (term ending Fall 2020)

Kevin Manor, Toyota

Mark Matsco, Covestro, LLC

Brenda Moyer, Dana Inc.

Seth Newlin, Oshkosh Corp. (term ending Fall 2020)

Christopher Oberski, Ford Motor Company

Steve Reasoner, Stryker (new member Spring 2020)

Christine Roberts, Twilio

Paul Rogers, Michigan Department of Military & Veterans Affairs

Peter Sandretto, FCA US, LLC (Retired)

William Schell, Caterpillar, Inc.

Robert Sharpe, Cummins, Inc.

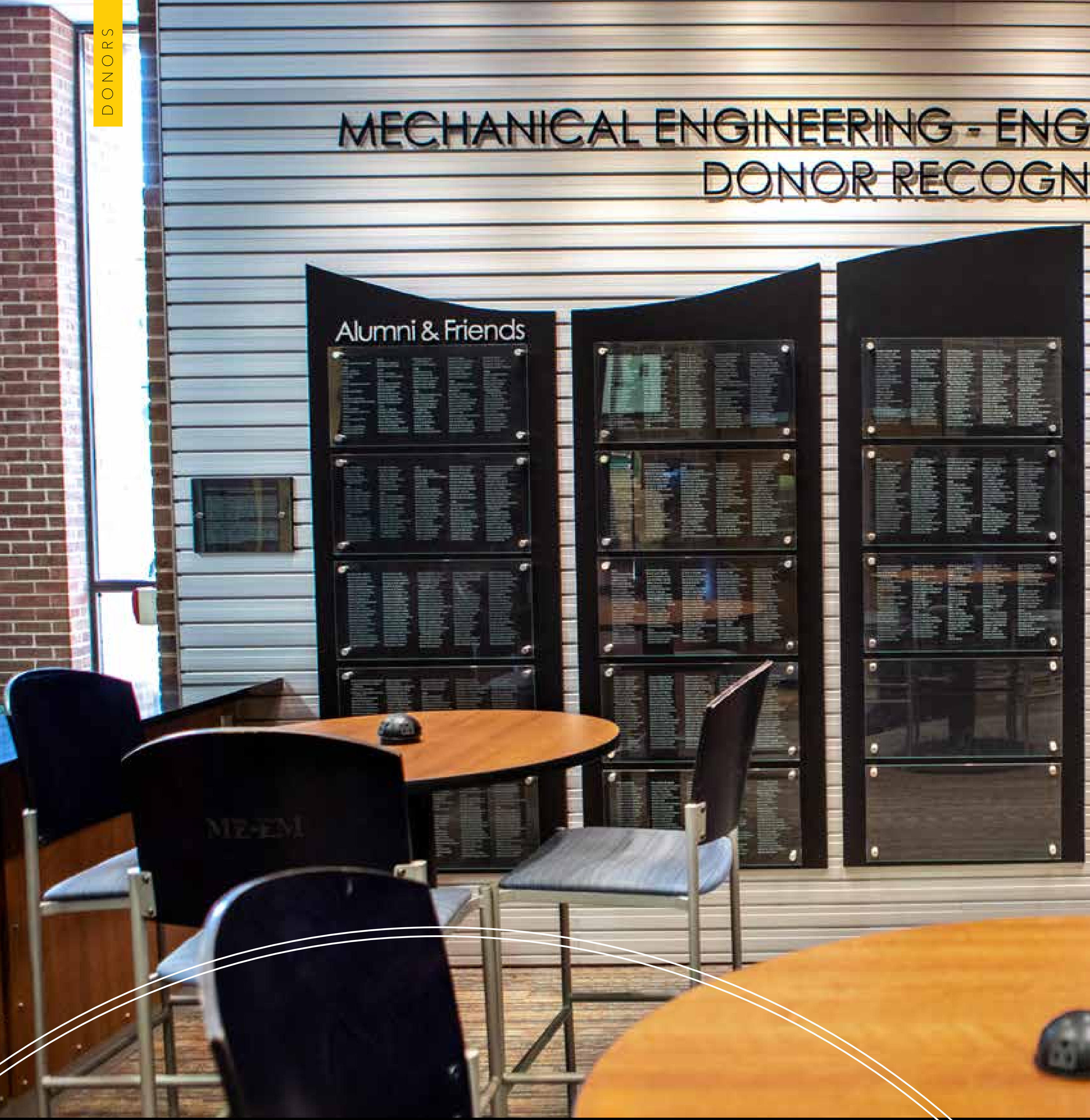
Darrin Traczyk, 3M (new member Spring 2020)

Jennifer Trice, 3M (term ending Fall 2020)

Jason Verboomen, Kimberly Clark Corp.

Brian Witt, Ariens Company

Chris Yakes, Oshkosh Corp. (new member Spring 2020)



ME-EM DONOR WALL

The new donor wall permanently and tangibly recognizes those who have shared financial gifts with the Department.

We are moved by their willingness to share their treasure with us.

These words of appreciation are inscribed on the wall:

Our alumni, friends, and benefactors who demonstrate a commitment to the tradition of yesterday and the vision of tomorrow, seek through their generosity to ensure that the highest quality of education and research will be available for future generations. The Department of Mechanical Engineering-Engineering Mechanics proudly recognizes and honors these donors in perpetuity.

> *"Over the years, listening to everyone's stories about their time at Michigan Tech has meant a great deal to me. I've especially enjoyed learning how much their experience means to them personally—its major impact on their careers—so much that they want to give back in support of our students, faculty and staff."*
>
> *—Dr. Bill Predebon, ME-EM Department Chair*

ME-EM CHAIR'S PHILANTHROPIC ADVISORY BOARD (CPAB)

Inaugural members began their four-year terms on July 1. This group of appointees will actively assist the Department chair in fundraising.

Interested in joining CPAB? Nominations and self-nominations are welcomed and accepted.

> *"My intent was to create a strong philanthropic support system for the Department and for future Department chairs."*
>
> *—Dr. Bill Predebon*

MEMBERS

- John F. Calder '67
- Marie Cleveland '82
- Tim Thomas '81
- Leslie Kilgore '95
- Bob Price '75
- Geoff Weller '75
- Gary Grinn '69

2019-20 DONORS

Donations by Michigan Tech alumni and friends contributed directly to the ME-EM Department, through scholarships that benefit ME students, and to emergency assistance funds set up for Michigan Tech students during the COVID-19 pandemic have been critical to the success of the Department.

The following list encompasses the many people who have generously shared their treasure to create an outstanding ME-EM Department. We are extremely grateful for their ongoing support.

Those contributing directly to the ME-EM Department from June 1, 2019 to August 1, 2020 are listed below. Note: Employee matching gifts are listed among individuals, below.

INDIVIDUALS

$2,000,000+

Dr. John O. '72 & Candace Hallquist

$200,000 - $699,999

Julian R. Ronse '47

$50,000 - $199,999

John '64 & Cathi Drake
Roger W. Lange '57
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Naga Nithin Kondipati '16
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Judy '83 & Tod Swann
Mary E. Symons
Thomas J. Tanciar '75
Richard W. Temple '58
Kurt J. Terhune '10
Matthew C. Tier '00
William '71 & Judy Todd
Susan W. Trahan '87
Jennifer L. Trice '82
Vincent '80 & Andrea Ursini
Kenneth '73 & Karen Van Kley
Jason '00 & Elizabeth Verboomen
Peter '74 & Barbara Volk
Jamie L. Walker '92
David L. Walter '15
Donna '80 & Harold Walters
Phillip '56 & Nancy Walters
John P. Wanhainen '51
Thomas '83 & Synthia Webb
Richard '53 & Mary Weinert
Grace P. West '21
Benjamin E. Westrope '06
Michael J. Wheeler '01
Levi E. Whipple '16
Gail '63 & Linda Wickstrom
Harold '68 & Claudia Wiens
Ronald '57 & Laura Wiersema
Joan & Gilbert Wirkner
Robert '65 & Elizabeth Wise
William '64 & Barbara Worman
Michael '68 & Dorothy Wozniak
Alice E. Wright '85
Krista '94 & Shane '92 Yokom
James '70 & Diane Zechlinski
Yongxing '86 & Yan Zhang
Liang Zhou '05
David '73 & Ann Zielinski

COMPANIES

$100,000 – $599,999
General Motors Company LLC
Ford Motor Company

$20,000 - $29,999
Cummins Inc.

$10,000 - $19,999
Fluid System Components Inc.
MacLean-Fogg Component Solutions
Polaris Industries Inc.

$1,000 - $9,999
Oculus Inc.
Barr Engineering Company
FEV Inc.
Marathon Petroleum Company LP

$100 - $999
Halliburton PAC
Koford Engineering LLC

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MICHIGAN TECH AEROSPACE ENTERPRISE WILL LAUNCH ITS SECOND STUDENT-BUILT SPACECRAFT IN 2021.

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Designed and built by students in the Aerospace Enterprise under faculty advisor, Dr. Brad King, STRATUS will be inside the SpaceX Dragon cargo capsule on a Falcon 9 rocket, traveling to the International Space Station in March 2021. Once docked, STRATUS will be placed in the Kibo Module's airlock for deployment in space. In orbit, the hard work of more than 200 students and alumni will be realized, as STRATUS begins collecting cloud data, funded through NASA's Undergraduate Student Instrument Program and CubeSat Launch Initiative.